SOIL SURVEY OF

Broadwater County Area, Montana

United States Department of Agriculture
Soil Conservation Service

In cooperation with
Montana Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1965-70. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1972. This survey was made cooperatively by the Soil Conservation Service and the Montana Agricultural Experiment Station. It is part of the technical assistance furnished to the Broadwater County Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for farming, industry, or recreation.

Locating Soils

All the soils of the Broadwater County Area are shown on the detailed map at the back of this survey. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with numbers on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the survey area in alphabetic order by map symbol. It shows the page where each kind of soil is described and the page for the dryland and irrigated capability units, range site, and windbreak suitability group in which the soil has been placed.

Individual colored maps that show the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of the interpretative groups.

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range and the names of many of the plants that grow on each range site.

Engineers, builders, and community planners can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Community planners and others concerned with recreational development can learn about the soil properties that affect the choice of sites for selected recreational uses in the section "Use of the Soils for Recreation."

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in the Broadwater County Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the survey area.

Contents

(*Contents continued next page*)

Summary of Tables

Issued April 1977

SOIL SURVEY OF BROADWATER COUNTY AREA, MONTANA

BY J. ART OLSEN, MERVYN H. HAUB, AND LAMONTE C. BINGHAM, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH MONTANA AGRICULTURAL EXPERIMENT STATION

BROADWATER COUNTY AREA, in the southwestern part of Montana (fig. 1), has an area of 842 square miles, or 539,111 acres. It is in an intermontane basin between the Big Belt Mountains to the east and the Elkhorn Mountains to the west. Except for the lands within the Helena National Forest, the survey area covers Broadwater County.

The Jefferson River forms the southern boundary of the survey area from its most southern point to the point where the Gallatin, Madison, and Jefferson Rivers join to form the Missouri River. The Missouri River, from its point of beginning to the town of Lombard, forms part of the boundary between the Broadwater County Area and Gallatin County. Jefferson County borders the survey area on the northwest and southwest, and Lewis and Clark County borders it on the north. The Helena National Forest boundary, which is partly in Broadwater County, borders the survey area on the east, northeast, and west.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in the Broadwater County Area, where they are located, and how they can be used. The soil scientists went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

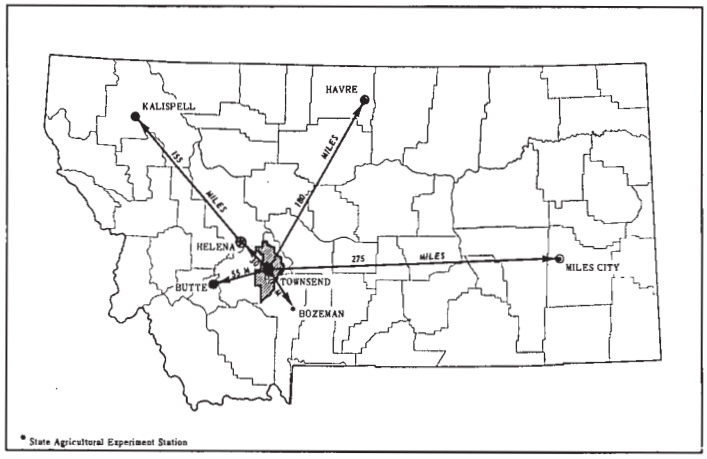


Figure 1.—Location of Broadwater County Area in Montana.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Toston and Radersburg, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Amesha cobbly sandy loam, 1 to 4 percent slopes, is one of several phases within the Amesha series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

A mapping unit consists of all the areas shown on a map that are identified by a common symbol. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of the Broadwater County Area. A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Chinook-Crago complex, 5 to 9 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous land types and are given descriptive names. Mine dumps is a land type in this survey area.

While a survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to the slow permeability of the soil or to a high water table. They see that streets, road pavements, and foundations for houses are cracked on a soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Broadwater County Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map that shows soil associations is useful to people who want a general idea of the soils in a survey area, who want to compare different parts of a survey area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of these broad groups and the soil associations in each group are described in the following pages.

Soils on Bottom Land

The soils on bottom land are in one soil association and formed in material deposited by the Missouri River and its tributaries. Most of the soils have slopes of 1 to 5 percent. They are poorly drained to moderately well drained and have a seasonal high water table. Some of them are subject to annual flooding.

1. Villy-Toston-Rivra association

Nearly level to gently sloping and gently undulating, deep, poorly drained to moderately well drained soils on low terraces and flood plains

This nearly level to gently sloping and gently undulating soil association is on flood plains and low terraces along the major streams in the survey area. Most of the area has an irregular surface because of past and present stream channels on the flood plain.

This soil association makes up about 6 percent of the survey area. It is about 18 percent Villy soils, 15 percent Toston soils, and 9 percent Rivra soils. The remaining 58 percent is minor soils.

Villy soils are poorly drained and nearly level. They are on low stream terraces. These soils have a surface layer of light-gray silty clay loam about 7 inches thick. The underlying material is stratified light-gray and gray silty clay loam and silt loam. Where they have not been drained, these soils have a seasonal high water table at a depth of less than 20 inches during most of the year.

Toston soils are nearly level to gently sloping and gently undulating. They are on low stream terraces and flood plains. These soils have a surface layer of grayish-brown silty clay loam about 2 inches thick and a subsoil of gray silty clay about 6 inches thick. The underlying material to a depth of about 34 inches is very pale brown and light-gray silty clay loam and silt loam. Below this, it is stratified light-gray sandy loam, loam, and loamy sand. These soils have a seasonal high water table at a depth of 36 to 72 inches.

Rivra soils are nearly level to gently sloping and gently undulating. They are on low terraces. These soils have a surface layer of light brownish-gray and grayish-brown gravelly loam about 4 inches thick. The underlying material is light brownish-gray very gravelly sand. These soils have a seasonal high water table at a depth of 36 to 72

inches for more than 60 consecutive days during peak streamflow late in spring and early in summer. Some areas are subject to annual overflow.

The minor soils are mainly Fairdale, Dominic, and Scravo soils, Aeric Fluvaquents, and Fluvaquentic Haplaquolls.

This soil association is used mainly for pasture and hay. Some areas are drainable, but the areas near the streams are not.

Soils Mainly on Intermediate Terraces and Fans

The soils on intermediate terraces and fans are in three soil associations and formed in material deposited by water and wind. The wind-deposited material contains a high proportion of silt and very fine sand. The water-laid material is mostly loam and clay loam that contains varying amounts of gravel and cobbles. The soils have slopes of 0 to 35 percent and are mostly deep. They are well drained and somewhat excessively drained.

2. *Amesha-Brocko-Mussel association*

Nearly level to steep, deep, well-drained soils on terraces and fans

This nearly level to steep soil association is on long terraces and fans between the Missouri River or its tributaries and the adjoining uplands. The area is smooth except where intermittent streams dissect the landscape.

This soil association makes up about 23 percent of the survey area. It is about 31 percent Amesha soils, 20 percent Brocko soils, and 11 percent Mussel soils. The remaining 38 percent is minor soils.

Amesha soils are nearly level to sloping and are on broad fans. These soils have a surface layer of light brownish-gray loam about 4 inches thick. The underlying material is very pale brown, strongly calcareous loam.

Brocko soils are nearly level to steep, but in most areas they are gently undulating. They are on broad terraces. These soils have a surface layer of light-gray silt loam about 7 inches thick. The underlying material is light-gray and very pale brown, strongly calcareous silt loam.

Mussel soils are nearly level to sloping and are on stream terraces and fans. These soils have a surface layer of light brownish-gray loam about 7 inches thick. The underlying material is strongly calcareous, light-gray, light brownish-gray, and very pale brown stratified loam, silt loam, and loamy sand.

The minor Musselshell and Thess soils are fairly well distributed throughout the association along low ridges. Scravo soils are mostly along intermittent streams.

This association includes the majority of the irrigated and dryfarmed cropland in the survey area. Sugar beets, small grains, alfalfa, and potatoes are well suited. Most of the soils used for dryfarmed crops are suitable for irrigation.

3. *Radersburg-Hilger-Scravo association*

Nearly level to steep, deep, well-drained and somewhat excessively drained soils on terraces, fans, and mountain foot slopes.

This nearly level to steep soil association is on stream terraces, fans, and foot slopes. The terraces and fans have irregular surfaces because they are dissected by numerous intermittent streams. The foot slopes are mostly smooth.

This soil association makes up about 8 percent of the survey area. It is about 38 percent Radersburg soils, 14 percent Hilger soils, and 13 percent Scravo soils. The remaining 35 percent is minor soils.

Radersburg soils are well drained and gently sloping. They are on broad fans and terraces. These soils have a surface layer of grayish-brown very cobbly loam about 4 inches thick and a subsoil of brown cobbly clay about 10 inches thick. The underlying material to a depth of about 30 inches is light-gray, strongly calcareous cobbly silt loam. Below this, it is light yellowish-brown moderately calcareous very cobbly loam.

Hilger soils are well drained and sloping to steep. They are on fans and foot slopes. These soils have a surface layer of very dark grayish-brown extremely stony loam about 3 inches thick and a subsoil of dark grayish-brown and brown very stony clay about 8 inches thick. The underlying material is light-gray, white, and pale-brown very stony and very cobbly clay loam.

Scravo soils are somewhat excessively drained and nearly level to gently sloping. They are on stream terraces. These soils have a surface layer of grayish-brown cobbly loam about 6 inches thick. The underlying material to a depth of about 17 inches is light-gray and light brownish-gray, strongly calcareous cobbly loam and very gravelly sandy loam. Below this is light-gray very gravelly loamy sand.

The minor Dominic, Perma, and Thess soils occur intermittently throughout the association but most commonly with Radersburg and Scravo soils.

This soil association is used mainly for range. Some smooth areas of Scravo soils are irrigated and used for hay and pasture.

4. *Chinook-Amesha association*

Nearly level to steep, deep, well-drained soils on terraces, fans, and uplands

This nearly level to steep soil association is on terraces, fans, and uplands. The area is smooth except where intermittent streams dissect the landscape.

This soil association makes up about 4 percent of the survey area. It is about 56 percent Chinook soils and 32 percent Amesha soils. The remaining 12 percent is minor soils.

Chinook soils are nearly level to steep and are on fans, terraces, and uplands. These soils have a surface layer of grayish-brown sandy loam about 8 inches thick and a subsoil of brown and light yellowish-brown sandy loam and gravelly sandy loam about 11 inches thick. The underlying material is light-gray, white, and very pale brown stratified gravelly sandy loam and gravelly sandy clay loam. In some areas the surface layer is gravelly and cobbly.

Amesha soils are nearly level to sloping and are on broad terraces and fans. These soils have a surface layer of light brownish-gray loam about 4 inches thick. The underlying material is very pale brown, strongly calcareous loam.

The minor Crago and Musselshell soils are mainly on the low, complex parts of the landscape.

This soil association is used mainly for irrigated and dryfarmed crops. Some areas are used for pasture and range. Some of the soils that are not cultivated could be used for irrigated crops under sprinkler irrigation.

Soils Mainly on High Terraces and Fans

The soils on high terraces and fans are in four soil associations and formed in material deposited by water and in material weathered in place from bedrock. The soils have slopes of 2 to more than 35 percent. They range from shallow to deep and contain varying amounts of cobbles, gravel, and stones.

5. *Sappington-Martinsdale association*

Gently sloping and sloping, deep, well-drained soils on terraces, fans, and benches

This gently sloping and sloping soil association is on high fans, benches, and terraces near the mountains. The fans and terraces are generally long but vary in width. They are bordered by deep, intermittent and perennial streams.

This soil association makes up about 6 percent of the survey area. It is about 54 percent Sappington soils and 38 percent Martinsdale soils. The remaining 8 percent is minor soils.

Sappington soils are gently sloping and sloping and are on benches and terraces. These soils have a surface layer of grayish-brown clay loam about 6 inches thick and a subsoil of brown gravelly clay loam about 3 inches thick. The underlying material is white and light-gray loam and gravelly loam.

Martinsdale soils are gently sloping and sloping and are on terraces and fans. These soils have a surface layer of dark grayish-brown loam about 8 inches thick and a subsoil of brown clay loam about 8 inches thick. The underlying material is white and light-gray channery loam and channery clay loam.

The minor Musselshell, Crago, and Perma soils are mostly moderately steep and steep and are on the side slopes of drainageways.

This soil association is used mainly for dryfarmed winter wheat. Some areas are used for irrigated crops and range.

6. *Passcreek-Bridger-Rooset association*

Sloping and rolling to steep, moderately deep and deep, well-drained soils on terraces and fans, and on benches, ridges, and side slopes of uplands

This sloping to steep soil association is on high terraces and fans near the mountains and on upland benches, ridges, and side slopes. Areas of this association are large and have both single, smooth slopes and rolling, complex slopes. The landscape is dissected by deep, intermittent and perennial streams.

This soil association makes up about 5 percent of the survey area. It is about 29 percent Passcreek soils, 18 percent Bridger soils, and 15 percent Rooset soils. The remaining 38 percent is minor soils.

Passcreek soils are sloping and rolling to steep and are on benches, ridges, and side slopes. These soils have a surface layer of grayish-brown channery silt loam about 7 inches thick and a subsoil of grayish-brown and pale-brown silty clay loam about 7 inches thick. The underlying material is white and pale-yellow channery and very channery silt loam and very channery clay loam. Bedrock is at a depth of about 38 inches.

Bridger soils are sloping and moderately steep and are on long, smooth fans and terraces. These soils have a surface layer of very dark gray cobbly loam about 6 inches thick and a subsoil of dark grayish-brown, brown, and pale-brown, mostly gravelly and very gravelly clay loam about 22 inches thick. The underlying material is light brownish-gray and light-gray, strongly calcareous channery clay loam.

Rooset soils are moderately steep to steep and are on fans and terraces near the mountains. These soils have a surface layer of dark grayish-brown extremely stony loam about 3 inches thick. The subsoil is about 21 inches thick. It is dark grayish-brown stony clay loam in the upper part, brown very cobbly light clay in the middle part, and pale-brown very stony clay loam in the lower part. The underlying material is strongly calcareous, very pale brown very stony clay loam.

The minor soils are in the Windham, Martinsdale, Nielsen, and Lake Creek series. The Nielsen soils are on ridges with Passcreek soils. The timbered Lake Creek soils have steep, north-facing slopes. The other minor soils are mostly on steep sides of drainageways.

Bridger silt loam and Passcreek soils are used mainly for winter wheat and barley. Bridger cobbly loam is used for pasture, hay, and range. Rooset soils are used only for range.

7. *Lake Creek-Whitore-Loberg association*

Moderately steep to very steep, moderately deep and deep, well-drained soils on mountainous uplands and high fans

This moderately steep to very steep soil association is on high fans and mountain side slopes and ridges. Slopes range from 10 percent to more than 60 percent. Sharp ridges, deep canyons, and fans are common. North-facing slopes are uniformly timbered, but grassland park areas are common along ridges and on the upper parts of south-facing slopes. Rocky ridges and areas of Rock outcrop are visible above the timber on parts of the association.

This soil association makes up about 3 percent of the survey area. It is about 25 percent Lake Creek soils, 23 percent Whitore soils, and 18 percent Loberg soils. The remaining 34 percent is minor soils and Rock outcrop.

Lake Creek soils are steep and very steep and are on sides of canyons. These soils have about 2 inches of forest litter over a surface layer of light brownish-gray channery loam about 9 inches thick. The subsoil, about 11 inches thick, is pale-brown channery loam. The underlying material is light-gray channery loam and very channery loam. Argillite bedrock is at a depth of about 35 inches.

Whitore soils are steep and very steep and are on mountain side slopes. These soils have a 2-inch layer of forest litter over a surface layer of grayish-brown channery silt loam about 3 inches thick. The subsoil is light brownish-gray, calcareous channery loam about 11 inches thick. The underlying material is white, very strongly calcareous channery loam and very channery loam.

Loberg soils are moderately steep to steep and are on smooth fans and mountain foot slopes. These soils have about 3 inches of forest litter over a surface layer of light-gray very stony loam about 4 inches thick. The next layer is grayish-brown and light brownish-gray channery clay loam about 4 inches thick. The subsoil, about 24 inches thick, is light olive-brown channery clay loam in the upper part, pale-brown channery clay in the middle part, and very pale brown very channery silty clay loam in the lower

part. The underlying material is very pale brown, white, and light olive-gray very channery silt loam.

The minor soils are in the Nielsen, Passcreek, Bridger, Tropal, and Woodrock series. Woodrock soils are mostly associated with Loberg soils. Tropal soils are in grassland park areas associated with Whitore soils. Nielsen, Passcreek, and Bridger soils are associated mostly with Lake Creek soils as grassland park areas on fans, ridges, and south-facing slopes.

This soil association is used for timber, woodland grazing, and wildlife habitat.

8. Musselshell-Crago association

Gently sloping to steep, deep, well-drained soils on terraces, fans, and foot slopes

This gently sloping to steep soil association is on long, narrow terrace remnants that are separated by deep, intermittent streams. Most of the ridges are smoothly rounded and are gently sloping or sloping. The fans and foot slopes on sides of the drainageways are moderately steep to steep.

This soil association makes up about 8 percent of the survey area. It is about 56 percent Musselshell soils and 25 percent Crago soils. The remaining 19 percent is minor soils.

Musselshell soils are gently sloping to steep and are on smooth uplands and terraces. These soils have a surface layer of light brownish-gray cobbly loam about 5 inches thick. The underlying material to a depth of 43 inches is light-gray and white gravelly loam. Below this, it is light brownish-gray very gravelly loamy sand.

Crago soils are gently sloping and sloping and are on high terraces, broad fans, and foot slopes that are dissected by drainageways. These soils have a surface layer of light brownish-gray cobbly loam about 4 inches thick. The underlying material is white and very pale brown gravelly loam, very gravelly sandy loam, and very gravelly loamy sand.

The minor soils are in the Cabbart, Delphill, Rootel, and Thess series.

This soil association is used for range.

Soils on Shale and Sandstone Uplands

The soils on shale and sandstone uplands are in one soil association. These soils formed in material weathered in place from clay shale, sandstone, and siltstone and are mostly clayey and loamy. They have slopes of 2 to 35 percent and range from shallow to moderately deep.

9. Abor-Cabbart-Delphill association

Gently sloping to steep, moderately deep and shallow, well-drained soils on uplands

This gently sloping to steep soil association is on undulating to rolling sedimentary uplands that are frequently dissected by intermittent streams. The drainageways are shallow to deep and have moderately steep to steep side slopes.

This soil association makes up about 3 percent of the survey area. It is about 30 percent Abor soils, 25 percent Cabbart soils, and 20 percent Delphill soils. The remaining 25 percent is minor soils and shale outcrop.

Abor soils are gently sloping to rolling and are on smooth uplands. These soils have a surface layer of grayish-brown, calcareous silty clay about 4 inches thick and a subsoil of grayish-brown and light yellowish-gray, calcareous clay about 19 inches thick. The underlying material to a depth of about 38 inches is light brownish-gray, partly weathered clay shale. Below this, it is platy clay shale.

Cabbart soils are moderately steep and steep and are on side slopes and ridges of the uplands. These soils have a surface layer of grayish-brown loam about 3 inches thick. The underlying material is very pale brown clay loam. Soft siltstone and sandstone are at a depth of about 15 inches.

Delphill soils are gently sloping to steep and are on side slopes and ridges of the uplands. These soils have a surface layer of light brownish-gray loam about 4 inches thick. The underlying material is pale-brown and very pale brown, strongly calcareous clay loam. Interbedded soft siltstone and loamy shale are at a depth of about 35 inches.

The minor soils are in the Rootel, Blanyon, Mussel, and Musselshell series. Shale outcrop is common along the drainageways.

This soil association is used for dryland small grains and range.

Soils on Mountainous Uplands

The soils on mountainous uplands are in two soil associations. These soils formed in material weathered from argillite, limestone, and igneous rock and in material that has moved downslope from the same source. They are gravelly loam to stony loam. They have slopes of 9 to 60 percent and range from shallow to deep.

10. Tropal-Rencot-Tolman association

Hilly to very steep, shallow, well-drained soils of the mountains

This hilly to very steep soil association is on mountainous uplands. The landscape is complex, consisting of smooth and round to sharp and narrow ridgetops and side slopes that range from sloping to very steep, and there are some steep-walled canyons. The association is drained by a branching pattern of smooth, grassed drainageways. Areas of Rock outcrop are common.

This soil association makes up about 20 percent of the survey area. It is about 22 percent Tropal soils, 18 percent Rencot soils, and 16 percent Tolman soils. The remaining 44 percent is minor soils and Rock outcrop.

Tropal soils are steep and very steep and are on ridges and side slopes. These soils have a surface layer of grayish-brown gravelly loam about 2 inches thick. The underlying material is very pale brown, strongly calcareous gravelly and very gravelly loam. Limestone bedrock is at a depth of about 19 inches.

Rencot soils are steep and are on ridges and side slopes. These soils have a surface layer of pale-brown channery loam about 4 inches thick. The underlying material is pale-yellow and white, strongly calcareous channery loam and very channery loam. Argillite bedrock is at a depth of about 18 inches.

Tolman soils are hilly to steep and are on ridges and side

slopes. These soils have a surface layer of brown channery loam about 2 inches thick and a subsoil of brown heavy channery loam about 5 inches thick. The underlying material is pale-brown, strongly calcareous very channery sandy clay loam. Argillite bedrock is at a depth of about 18 inches.

The minor soils are in the Musselshell, Crago, and Rootel series. Rock outcrop is common along ridgetops and points of hills.

This soil association is used only for range.

11. Cheadle-Nielsen-Ess association

Moderately steep and hilly to very steep, shallow and deep, well-drained soils of the mountains

This moderately steep and hilly to very steep soil association is on mountainous uplands. Generally, the ridges are sharp and narrow, the side slopes are steep and very steep, and the canyons are deep.

This soil association makes up about 14 percent of the survey area. It is about 33 percent Cheadle soils, 27 percent Nielsen soils, and 13 percent Ess soils. The remaining 27 percent is minor soils and Rock outcrop.

Cheadle soils are hilly and steep and are on ridges and side slopes. These soils have a surface layer of dark-brown stony loam about 3 inches thick. The underlying material is dark-brown very channery loam. Bedrock is at a depth of about 8 inches.

Nielsen soils are steep and very steep and are on ridges and side slopes. These soils have a surface layer of dark-gray channery loam about 5 inches thick. The subsoil is about 9 inches thick. The upper part is dark grayish-brown channery silty clay loam, and the lower part is pale-brown very channery silty clay loam. Strongly calcareous argillite bedrock is at a depth of about 14 inches.

Ess soils are steep and very steep and are on side slopes. These soils have a surface layer of very dark grayish-brown stony loam about 10 inches thick and a subsoil of grayish-brown and light yellowish-brown very stony clay loam about 40 inches thick. The underlying material is light yellowish-brown very stony loam.

The minor soils are in the Blaine, Windham, Lake Creek, Whitore, Loberg, and Woodrock series. Rock outcrop is common on ridges and points of hills.

This soil association is used mainly for range. Some areas are used for timber production. The soils are suitable for year-round recreation use.

Descriptions of the Soils

This section describes the soil series and mapping units in the Broadwater County Area. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series is described. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. The colors given are for a dry soil unless it is otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Mine dumps, for example, does not belong to a soil series but, nevertheless, is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is the symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability units, range site, and windbreak suitability group in which the mapping unit has been placed. The page for the description of each capability unit, and the range site and windbreak suitability group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The approximate acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the back of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual.[1]

Abor Series

The Abor series consists of moderately deep, well-drained soils on sedimentary uplands. These soils formed in material weathered from clay shale. Slopes range from 3 to 9 percent. Elevation ranges from 4,000 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown, calcareous silty clay about 4 inches thick. The subsoil is grayish-brown and light yellowish-gray, calcareous clay about 19 inches thick. The underlying material to a depth of 38 inches is light brownish-gray, partly weathered clay shale. Below this, it is light yellowish-brown platy clay shale.

Permeability is slow, and the available moisture capacity is low. Some plant roots penetrate the shale parent material. These soils crack when dry.

Abor soils are used for dryland crops and range.

Representative profile of Abor silty clay, 3 to 9 percent slopes, 1,900 feet north and 50 feet west of the SE. corner of sec. 7, T. 2 N., R. 1 E.:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, very fine, granular structure; slightly hard, friable, sticky and plastic; many fine roots; many fine pores; abrupt, smooth boundary.

B21—4 to 8 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; hard, firm, sticky and plastic; moderately thick clay films on peds; some dark-colored streaks indicate vertical cracking; clear, smooth boundary.

B22—8 to 23 inches, light yellowish-brown (2.5Y 6/4) clay, olive brown (2.5Y 4/4) moist; moderate, medium, prismatic structure; hard, firm, sticky and plastic; moderately thick continuous clay films on peds; dark streaks along vertical fractures; strongly effervescent; gradual, smooth boundary.

[1] United States Department of Agriculture. 1951. Soil Survey Manual. U.S. Dep. Agric. Hanb. 18, 503 pp., illus.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent	Soil	Acres	Percent
Abor silty clay, 3 to 9 percent slopes	3,759	0.7	Mussel-Musselshell complex, 5 to 9 percent slopes	708	.1
Aeric Fluvaquents	3,650	.7	Musselshell gravelly loam, 2 to 5 percent slopes	5,592	1.0
Amesha sandy loam, 1 to 4 percent slopes	4,773	.9	Musselshell gravelly loam, 5 to 9 percent slopes	3,736	.7
Amesha sandy loam, 4 to 9 percent slopes	569	.1	Musselshell-Crago channery loams, 15 to 35 percent slopes	39,895	7.4
Amesha cobbly sandy loam, 1 to 4 percent slopes	1,208	.3	Musselshell-Crago cobbly loams, 8 to 20 percent slopes	17,624	3.3
Amesha loam, 1 to 4 percent slopes	31,505	5.9	Musselshell-Thess cobbly loams, 3 to 8 percent slopes	7,041	1.3
Amesha loam, 4 to 9 percent slopes	9,731	1.9	Nielsen channery loam, 15 to 60 percent slopes	25,771	4.8
Blaine-Cheadle complex, 10 to 25 percent slopes	8,143	1.6	Passcreek channery silt loam, 6 to 15 percent slopes	6,708	1.2
Blanyon clay loam, 3 to 10 percent slopes	1,587	.3	Passcreek-Lake Creek channery loams, 15 to 35 percent slopes	3,160	.6
Borohemists	335	(1)	Perma very cobbly loam	2,390	.4
Bridger cobbly loam, 5 to 15 percent slopes	3,274	.6	Perma very cobbly loam, wet	2,809	.5
Bridger silt loam, 5 to 15 percent slopes	1,437	.3	Radersburg very cobbly loam	13,871	2.6
Brocko silt loam, 0 to 2 percent slopes	5,251	1.0	Rencot channery loam, 15 to 35 percent slopes	27,774	5.1
Brocko silt loam, 2 to 5 percent slopes	12,516	2.1	Rivra gravelly loam	2,983	.6
Brocko silt loam, 5 to 9 percent slopes	4,040	.7	Rooset extremely stony loam, 9 to 35 percent slopes	4,030	.7
Brocko silt loam, 9 to 25 percent slopes	1,596	.3	Rootel channery loam, 3 to 9 percent slopes	2,869	.5
Brocko silt loam, wet, 0 to 2 percent slopes	1,945	.4	Sappington clay loam, 2 to 5 percent slopes	8,330	1.5
Cabbart complex, 9 to 35 percent slopes	11,216	2.1	Sappington clay loam, 5 to 9 percent slopes	6,034	1.1
Cheadle stony loam, 9 to 35 percent slopes	24,825	4.7	Sappington gravelly clay loam, 2 to 5 percent slopes	1,143	.2
Chinook sandy loam, 1 to 4 percent slopes	4,979	.9	Sappington gravelly clay loam, 5 to 9 percent slopes	1,900	.4
Chinook sandy loam, 4 to 9 percent slopes	530	(1)	Scravo cobbly loam	4,068	.8
Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes	2,284	.4	Scravo very cobbly loam	4,652	.9
Chinook-Crago loamy sands, 1 to 9 percent slopes	1,359	.3	Thess silt loam	14,453	2.7
Chinook-Crago complex, 5 to 9 percent slopes	2,805	.5	Thess-Scravo complex	3,342	.6
Chinook-Crago complex, 9 to 35 percent slopes	1,887	.3	Tolman channery loam, 10 to 35 percent slopes	25,001	4.6
Crago complex, 4 to 9 percent slopes	2,650	.5	Toston silty clay loam	4,804	.9
Delphill loam, 2 to 5 percent slopes	2,134	.4	Tropal-Rock outcrop complex, 15 to 60 percent slopes	40,860	7.6
Delphill-Abor complex, 5 to 20 percent slopes	5,571	1.1	Ustic Torrifluvents	6,252	1.2
Dominic soils	2,265	.4	Ustic Torriorthents, saline	5,490	1.0
Ess-Cheadle complex, 35 to 60 percent slopes	10,966	2.0	Villy silty clay loam	4,835	.9
Fairdale silt loam	3,028	.6	Villy silty clay loam, drained	849	.2
Fairdale-Lothair silty clays	843	.2	Whitore channery silt loam, 25 to 60 percent slopes	4,639	.9
Fluvaquentic Haplaquolls	4,960	.9	Windham cobbly loam, 9 to 35 percent slopes	4,348	.8
Havre loam	1,101	.2	Woodrock-Loberg complex, 15 to 60 percent slopes	1,229	.2
Hilger extremely stony loam, 8 to 25 percent slopes	9,876	1.8	Woodrock-Rock outcrop complex, 15 to 35 percent slopes	2,657	.5
Lake Creek channery loam, 20 to 50 percent slopes	6,250	1.1	Total	539,111	100.0
Loberg very stony loam, 10 to 35 percent slopes	2,632	.5			
Lothair silty clay	1,720	.3			
Martinsdale loam, 2 to 5 percent slopes	4,885	.9			
Martinsdale loam, 5 to 9 percent slopes	6,219	1.1			
Martinsdale cobbly loam, 2 to 9 percent slopes	2,847	.5			
Mine dumps	1,500	.3			
Mussel loam, 0 to 2 percent slopes	3,753	.7			
Mussel loam, 2 to 5 percent slopes	5,280	1.0			
Mussel-Crago complex	2,583	.5			
Mussel-Musselshell complex, 2 to 5 percent slopes	988	.2			

[1] Less than 0.1 percent.

C1—23 to 38 inches, light brownish-gray (2.5Y 6/2) partly weathered clay shale and shale chips, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky and plastic; strongly effervescent; common fine, distinct nests and seams of calcium sulfate; clear, smooth boundary.

C2—38 to 60 inches, variegated colors of light yellowish-brown (2.5Y 6/4) and light brownish-gray (2.5Y 6/2) platy clay shale, light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) moist.

The solum ranges from 10 to 24 inches in thickness. Depth to clay shale ranges from 20 to 40 inches. The soil formed in material weathered from clay shale; however, in places the lower part of the C horizon has some soft sandstone layers.

The A and B horizons have a hue of 2.5Y or 10YR, a chroma of 2 or 3, and a value of 5 or 6 when dry and 3 or 4 when moist.

AbC—Abor silty clay, 3 to 9 percent slopes. This gently sloping and rolling soil is on shale uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Delphill loam, Blanyon clay loam, and some silty clay soils that are only 8 to 20 inches deep over clay shale. The Delphill soils are in small, 1- to 5-acre areas near the edges of the unit. The Blanyon soils are mostly along drainageways. The shallow silty clay soils are on and around sharp knolls and ridges. Spots of saline-alkali affected soils are also included along the intermittent stream drainageways.

The hazard of soil blowing is severe. Runoff is rapid.

The soil is used for dryland winter wheat and range. Capability unit IIIe-4, dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Aeric Fluvaquents

Af—Aeric Fluvaquents (0 to 5 percent slopes). These are somewhat poorly drained and poorly drained, loamy soils. They are nearly level and gently sloping and are on low terraces and bottom lands along intermittent and perennial streams. The soil surface is somewhat irregular because of channels and ridges. Areas of poorly drained soil make up about 30 percent of the unit. The surface layer ranges from sandy loam to clay loam, but it is mostly loam.

The soils range from 10 to more than 60 inches thick over sandy gravel, but in most areas sandy gravel is at a depth of 36 to 60 inches. Small gravelly and very gravelly areas make up less than 20 percent of the unit.

Most of the soils in this unit are subject to annual flooding. They have a seasonal high water table at a depth of 20 to 60 inches. The hazard of erosion is moderate to high, and runoff is medium.

This unit is used mainly for range. Capability unit VIw-1, dryland; Subirrigated range site, 10- to 14-inch precipitation zone; windbreak suitability group 2W.

Amesha Series

The Amesha series consists of deep, well-drained soils on broad fans and terraces. These soils formed in strongly calcareous, stratified alluvium. Slopes range from 1 to 9 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray loam about 4 inches thick. The underlying material, to a depth of 74 inches, is very pale brown, strongly calcareous loam.

Permeability is moderate, and the available moisture capacity is high.

Amesha soils are used mainly for dryland crops. Some areas are irrigated, and some are used for range.

Representative profile of Amesha loam, 1 to 4 percent slopes, 1,200 feet east and 1,100 feet north of the SW. corner of sec. 25, T. 4 N., R. 1 E.:

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; 5 percent fine gravel; strongly effervescent; abrupt, smooth boundary.

C1ca—4 to 10 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; weak, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many fine tubular pores; 5 percent fine gravel; violently effervescent; common soft masses of calcium carbonate and lime casts on undersides of gravel; clear, wavy boundary.

C2ca—10 to 28 inches, very pale brown (10YR 8/3) loam, very pale brown (10YR 7/3) moist; weak, coarse, blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine tubular pores; 5 percent fine gravel; violently effervescent;many large, soft masses of calcium carbonate; clear, wavy boundary.

C3ca—28 to 49 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) moist; weak, coarse, blocky structure parting to weak, fine, platy; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent gravel; violently effervescent; few soft masses of calcium carbonate; clear, wavy boundary.

C4—49 to 74 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) moist; massive; hard, friable, slightly sticky and slightly plastic; 15 percent fine gravel; violently effervescent.

The soil has a hue of 10YR or 2.5Y. The A horizon has a value of 5 to 7 when dry and 4 or 5 when moist and a chroma of 2 or 3.

The A horizon is cobbly in places. Between depths of 10 and 40 inches, texture is mostly loam and sandy loam. The Cca horizon ranges from 15 to 35 percent calcium carbonate.

AmB—Amesha sandy loam, 1 to 4 percent slopes. This nearly level and gently sloping soil is on long stream terraces and fans that are gently undulating across the slope. This soil has a profile similar to the one described as representative of the series, but the surface layer is sandy loam 8 to 15 inches thick.

Included with this soil in mapping, and making up less than 15 percent of the mapped areas, are small areas of Amesha loam, Mussel loam and Chinook sandy loam.

The hazard of soil blowing is severe. Runoff is slow.

This soil is used for irrigated alfalfa, potatoes, and sugar beets. Some areas are used for dryland winter wheat and pasture. Capability units IIIe-2, dryland, and IIe-1, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

AmC—Amesha sandy loam, 4 to 9 percent slopes. This soil is gently sloping, sloping, gently undulating, and rolling. It is on fans and stream terraces. It has a profile similar to the one described as representative of the series, but the surface layer is sandy loam 8 to 15 inches thick.

Included with this soil in mapping are small, 5- to 10-acre areas of Chinook sandy loam and Mussel loam. Also included, where this unit is bordered by hilly areas, are some areas of Crago gravelly or cobbly loams that finger down into the unit. Included soils make up about 20 percent of the mapped areas.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for dryland winter wheat. Some areas are used for irrigated alfalfa, wheat, and range. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

AnB—Amesha cobbly sandy loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on fans and stream terraces that have occasional low mounds and ridges. This soil has a profile similar to the one described as representative of the series, but the surface layer is gravelly and cobbly sandy loam.

Included with this soil in mapping are some small areas of Musselshell and Crago cobbly sandy loams. The Musselshell soils occur in an unpredictable pattern in 5- to 20-acre areas throughout the unit. The Crago soils are on the low mounds and ridges in areas 1 acre to 5 acres in size. Included soils make up about 30 percent of the mapped areas.

The hazard of soil blowing is moderate. Runoff is slow.

This soil is used mostly for dryland winter wheat and range. Some areas are irrigated. Capability units IIIe-2, dryland, and IIe-1, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

AoB—Amesha loam, 1 to 4 percent slopes. This nearly level and gently sloping soil is on broad fans and terraces that are commonly dissected by channels of intermittent streams. An occasional low mound or ridge breaks the smoothness of the landscape. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas, less than 5 acres in size, of Musselshell and Mussel soils. These soils are generally on the low mounds and ridges, and in places they are gravelly. Also included along the east side of Canyon Ferry Lake are areas of soils that have a surface layer of silt loam. Included soils make up 10 to 20 percent of the mapped areas.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for dryland winter wheat. Some areas are irrigated, and some are used for range. Capability units IIIe-2, dryland, and IIe-1, irrigated; Limy range site, 10- to 14- inch precipitation zone; windbreak suitability group 3L.

AoC—Amesha loam, 4 to 9 percent slopes. This gently sloping and sloping soil is on fans and terraces that are dissected by drainageways of intermittent streams. Slopes are mainly 5 percent. This soil has a profile similar to the one described as representative of the series, but it is steeper.

Included with this soil in mapping along the east side of Canyon Ferry Lake are areas of soils that have a surface layer of silt loam. Also included are 5-to 10-acre areas of Chinook sandy loam and Crago gravelly loam, generally on convex positions. Included soils make up about 40 percent of the mapped areas.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for dryland winter wheat. Some areas are used for irrigated alfalfa, wheat, barley, and range. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Limy range site, 10- to 14- precipitation zone; windbreak suitability group 3L.

Blaine Series

The Blaine series consists of moderately deep, well-drained soils on low hills and foot slopes of the uplands. These soils formed in material weathered from igneous bedrock. Slopes range from 10 to 25 percent. Elevation ranges from 4,000 to 6,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 60 to 90 days.

In a representative profile the surface layer is grayish-brown gravelly loam about 4 inches thick. The subsoil is brown gravelly clay loam about 6 inches thick. The underlying material is light-gray and light olive-gray, calcareous gravelly loam and very gravelly loam. Fractured igneous bedrock is at a depth of about 24 inches.

Permeability is moderate, and the available moisture capacity is very low or low.

Blaine soils are used only for range.

Representative profile of Blaine gravelly loam in an area of Blaine-Cheadle complex, 10 to 25 percent slopes, 1,200 feet south and 600 feet west of the center of sec. 10, T. 5 N., R. 1 W.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; 35 percent gravel; mildly alkaline; clear, smooth boundary.

B2t—4 to 10 inches, brown (10YR 4/3) gravelly clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, fine, blocky; hard, friable, sticky and plastic; common fine and very fine roots; moderately thick clay films on peds and coarse fragments; 35 percent gravel and cobbles; mildly alkaline; clear, wavy boundary.

C1ca—10 to 16 inches, light-gray (2.5Y 7/2) gravelly loam, grayish brown (2.5Y 5/2) moist; weak, medium, prismatic structure parting to very fine, blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; 40 percent gravel and cobbles; violently efferevescent; many films and soft masses of calcium carbonate and lime casts on undersides of gravel and cobbles; clear, wavy boundary.

C2ca—16 to 24 inches, light olive-gray (5Y 6/2) very gravelly loam, olive (5Y 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; 50 percent gravel and cobbles; strongly effervescent; few soft masses of lime and many thin lime casts on undersides of gravel and cobbles; abrupt, wavy boundary.

R—24 inches, fractured igneous bedrock.

The solum ranges from 10 to 20 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. The soil mostly ranges from 35 to 65 percent, by volume, gravel, cobbles, and stones.

The A1 horizon has a hue of 10YR or 2.5Y, a value of 4 or 5 when dry and 2 or 3 when moist, and a chroma of 1 to 3. The B2t horizon is heavy gravelly loam or gravelly clay loam. It has a hue of 10YR or 2.5Y, a value of 4 or 5 when dry and 2 to 4 when moist, and a chroma of 2 or 3. The Cca horizon ranges from fine sandy loam to light clay loam. It has a hue of 10YR to 5Y, a value of 5 to 7 when dry and 4 to 6 when moist, and a chroma of 2 or 3. Accumulations of calcium carbonate range from faint to prominent.

BcE—Blaine-Cheadle complex, 10 to 25 percent slopes. This complex is about 40 percent Blaine gravelly loam, Blaine cobbly loam, and Blaine stony loam and about 30 percent Cheadle stony loam, Cheadle cobbly loam, and Cheadle gravelly loam. The surface layer is dominantly cobbly loam. The Blaine gravelly loam in this complex has the profile described as representative of the Blaine series. The Cheadle stony loam in this complex has a profile similar to that described as representative of the series. The profiles of the other Blaine soils and the Cheadle soils in this complex differ from the ones described as representative of their respective series only in the size and content of the coarse fragments in the surface layer. The Blaine and Cheadle soils are on low hills and mounds. The Cheadle soils are less than 20 inches deep over bedrock, and the Blaine soils are 20 to 40 inches deep over bedrock.

Included with these soils in mapping are small areas of Rootel soils, in valleys some loam soils that formed in alluvium and that are 20 to 40 inches deep over bedrock, and Rock outcrop. Also included in valleys are areas of soils that have slopes of less than 10 percent. Included soils make up about 30 percent of the mapped areas.

The hazard of erosion is moderate to high. Runoff is medium to rapid.

These soils are used for range. Capability unit VIe-1, dryland; windbreak suitability group 4; Blaine cobbly loam in Silty range site, 15- to 19-inch precipitation zone; Cheadle cobbly loam in Shallow range site, 15- to 19-inch precipitation zone.

Blanyon Series

The Blanyon series consists of deep, well-drained soils on terraces and fans. These soils formed in alluvium along intermittent streams in valleys. Slopes range from 3 to 10 percent. Elevation ranges from 4,200 to 4,800 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray loam about 3 inches thick. The subsoil is brown and pale-brown clay loam and clay about 15 inches thick. The underlying material to a depth of 50 inches is pale-brown, strongly calcareous clay loam. Below this, to a depth of 60 inches, it is very pale brown, calcareous loam.

Permeability is moderately slow, and the available moisture capacity is high. These soils crack when dry.

Blanyon soils are used mainly for range. They are suitable for crops.

Representative profile of Blanyon clay loam, 3 to 10 percent slopes, 1,200 feet east and 660 feet south of the W. quarter corner of sec. 23, T. 4 N., R. 1 W.:

A2—0 to 3 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate, fine, platy structure; slightly hard, very friable, slightly sticky and nonplastic; common roots; many very fine pores; platy soil peds coated with bleached silt and sand; abrupt, smooth boundary.

B&A—3 to 4 inches, grayish-brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, blocky structure parting to moderate, medium, platy; hard, friable, sticky and plastic; common roots; many very fine pores; soil peds coated with bleached silt and sand; mildly alkaline; abrupt, smooth boundary.

B21t—4 to 10 inches, brown (10YR 5/3) light clay, dark brown (10YR 4/3) moist; dark brown (10YR 3/3) coatings on peds; strong, medium, prismatic structure parting to strong, medium, blocky; very hard, firm, sticky and plastic; common roots; many very fine pores; thick continuous clay films on peds; moderately alkaline; clear, smooth boundary.

B3ca—10 to 18 inches, pale-brown (10YR 6/3) heavy clay loam, brown (10YR 5/3) moist; brown (10YR 4/3) coatings on peds; moderate, medium, prismatic structure; very hard, firm, sticky and plastic; common roots; many very fine pores; continuous clay films on vertical ped faces, patchy clay films on horizontal ped faces; strongly effervescent; common fine spots and threads of lime; moderately alkaline; gradual, wavy boundary.

C1ca—18 to 28 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; dark-brown (10YR 4/3) coatings on peds; weak, coarse, prismatic structure; hard, friable, sticky and plastic; few roots; many very fine pores; strongly effervescent; common fine spots and threads of lime; moderately alkaline; gradual, wavy boundary.

C2casa—28 to 50 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and slightly plastic; strongly effervescent; few fine spots, films, and seams of gypsum salts; moderately alkaline; gradual, wavy boundary.

C3—50 to 60 inches, very pale brown (10YR 8/3) loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

Depth to soft sandstone or siltstone ranges from 40 to more than 60 inches. The soil ranges from 0 to about 15 percent gravel throughout. The soil has a hue of 2.5Y or 10YR throughout.

The A2 horizon has a value of 6 or 7 when dry and 3 or 4 when moist and a chroma of 1 or 2 when dry. The B2t horizon has a value of 4 or 5 when dry and 3 or 4 when moist. The C horizon has a value of 6 to 8 when dry and 4 to 6 when moist and a chroma of 2 to 4.

BdC—Blanyon clay loam, 3 to 10 percent slopes. This gently sloping to moderately steep soil is in valleys of intermittent streams and on fans and terraces. Tributary drainageways dissect the terraces, and some isolated mounds rise above the valley floor. Slopes range from 3 to 10 percent but are mainly about 5 percent. Areas are long and narrow.

Included with this soil in mapping, and making up about 25 percent of the mapped areas, are areas of Sappington loam, Delphill loam, and Abor clay. The Sappington soil is in 2- to 10-acre areas among the Blanyon soils on the terraces. The Delphill and Abor soils are mostly on the mounds.

The hazard of erosion is moderate. Runoff is medium.

This soil is used for range. Capability unit IIIe-4, dryland; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Borohemists

Bo—Borohemists (0 to 2 percent slopes). These are nearly level, organic soils. They consist of a layer of fibrous material, 24 to 48 inches thick, that rests on mineral soil. A seasonal high water table is at a depth of 5 to 20 inches.

The only area of Borohemists in the survey area is in the Crow Creek Valley. It is about 335 acres in size. Capability unit VIw-1, dryland; Wetland range site, 10- to 19-inch precipitation zone; windbreak suitability group not assigned.

Bridger Series

The Bridger series consists of deep, well-drained soils on fans and terraces. These soils formed in alluvium. Slopes range from 5 to 15 percent. Elevation ranges from 4,800 to 5,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 60 to 90 days.

In a representative profile the surface layer is very dark gray cobbly loam about 6 inches thick. The subsoil is about 22 inches thick. It is dark grayish-brown clay loam in the upper part, brown gravelly clay loam in the middle part, and pale-brown very gravelly clay loam in the lower part. The underlying material, to a depth of 60 inches, is light brownish-gray and light-gray, strongly calcareous channery clay loam.

Permeability is moderate, and the available moisture capacity is moderate.

Bridger soils are used mainly for dryland crops and range. A few areas are irrigated.

Representative profile of Bridger cobbly loam, 5 to 15 percent slopes, 650 feet north of the center of sec. 36, T. 8 N., R. 3 E.:

A1—0 to 6 inches, very dark gray (10YR 3/1) cobbly loam, black (10YR 2/1) moist; weak, thin, platy structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; clear, smooth boundary.

B1—6 to 10 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to blocky; hard, friable, sticky and plastic; many fine pores; some bleached silt and sand grains on peds; clear, smooth boundary.

B21t—10 to 19 inches, brown (10YR 5/3) gravelly clay loam, dark brown (10YR 4/3) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium, blocky; hard, firm, sticky and plastic; many fine pores; thick continuous clay films on peds; clear, smooth boundary.

B22t—19 to 28 inches, pale-brown (10YR 6/3) very gravelly heavy clay loam, dark brown (7.5YR 3/3) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium, blocky; hard, firm, sticky and plastic; many fine pores; thick continuous clay films on peds; abrupt, smooth boundary.

C1ca—28 to 35 inches, light brownish-gray (2.5Y 6/2) channery clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky and slightly plastic; 30 percent channers; violently effervescent; many fine, prominent threads and nodules of lime, lime coatings on all fragments; clear, wavy boundary.

C2ca—35 to 60 inches, light-gray (2.5Y 7/2) channery clay loam, light yellowish brown (10YR 6/3) moist; massive; hard, friable, sticky and slightly plastic; 30 percent channers; violently effervescent; many fine, prominent nodules and splotches of segregated lime.

Depth to the Cca horizon ranges from 20 to 38 inches. The A and B horizons range from 15 to 35 percent, by weighted average, coarse fragments. Hue throughout is 7.5YR to 2.5Y.

The A horizon has a value of 3 or 4 when dry and 2 or 3 when moist. The B2t horizon has a value of 4 to 6 when dry and 3 or 4 when moist and a chroma of 2 to 4. It has a medium and coarse, prismatic structure that parts to medium and fine, blocky. It ranges from 35 to 40 percent clay. The C horizon has a value of 6 to 8 when dry and 5 to 7 when moist and a chroma of 2 or 3.

BpD—Bridger cobbly loam, 5 to 15 percent slopes. This sloping and moderately steep soil is on long, smooth fans and terraces at elevations of more than 5,000 feet. Most areas are several hundred acres in size. They are mostly on the west-facing slopes adjacent to the Big Belt Mountains. This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas of Bridger stony loam that make up less than 20 percent of the mapped areas. Also included are areas of Rooset cobbly

loam intermingled with Bridger soils and making up about 30 percent of the mapped areas.

The hazard of erosion is moderate or high. Runoff is medium or rapid.

This soil is used mostly for hay and range. Some areas are used for irrigated and dryland crops. Capability units IVe-2, dryland, and IVe-1, irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

BrD—Bridger silt loam, 5 to 15 percent slopes. This sloping and moderately steep soil is on fans and terraces at elevations of more than 5,000 feet. It is mostly on the west-facing slopes adjacent to the Big Belt Mountains. This soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam about 12 inches thick.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are some areas of Bridger gravelly loam and Bridger cobbly loam.

The hazard of erosion is moderate to high. Runoff is medium to rapid.

This soil is used mainly for range. Some areas are used for irrigated and dryland crops. Capability units IVe-2, dryland, and IVe-1, irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2M.

Brocko Series

The Brocko series consists of deep, well-drained soils on old river terraces and fans, some of which are dissected. These soils formed in wind-laid silt loam. Slopes range from less than 1 percent to 25 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light-gray silt loam about 7 inches thick. The underlying material to a depth of 75 inches is light-gray and very pale brown, strongly calcareous silt loam.

Permeability is moderate, and the available moisture capacity is high.

Brocko soils are used mainly for dryland winter wheat. Some areas are used for range, and a few areas are irrigated.

Representative profile of Brocko silt loam, 2 to 5 percent slopes, 1,600 feet east and 300 feet north of the SW. corner of sec. 6, T. 3 N., R. 1 E.:

Ap—0 to 7 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky and nonplastic; many roots; strongly effervescent; abrupt, smooth boundary.

C1ca—7 to 28 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) moist, weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine tubular pores; violently effervescent; common filaments and soft masses of calcium carbonate; gradual, smooth boundary.

C2—28 to 44 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine tubular pores; violently effervescent; clear, wavy boundary.

C3—44 to 75 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; violently effervescent; few soft masses and filaments of fine gypsum crystals.

Texture ranges from very fine sandy loam to silt loam throughout. The C1ca horizon ranges from 8 to 30 inches in thickness and is 15 to 35 percent calcium carbonate.

The A horizon has a hue of 10YR or 2.5Y, a value of 5 to 7 when dry and 4 to 6 when moist, and a chroma of 2 or 3. The C horizon has a hue of 10YR to 5Y, a value of 7 or 8 when dry and 4 to 6 when moist, and a chroma of 2 or 3.

BsA—Brocko silt loam, 0 to 2 percent slopes. This nearly level soil is on broad alluvial fans or stream terraces and formed in loess. It has a profile similar to the one described as representative of the series, but it is less sloping.

Included with this soil in mapping, and making up about 25 percent of the mapped areas, are areas of Havre loam and silty clay loam. Also included, and making up about 10 percent, are areas of Thess silt loam. The Thess soil is not present in all mapped areas. The Havre soil has a surface layer of loam or silty clay loam 8 to 15 inches thick.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used for irrigated alfalfa, sugar beets, corn silage, spring wheat, and dryland small grains. Capability units IIIe-2, dryland, and IIc-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

BsB—Brocko silt loam, 2 to 5 percent slopes. This gently undulating soil is on smooth terraces and formed in loess. The area is dissected by well-established drainageways. The soil has the profile described as representative of the series.

Included with this soil in mapping, and making up about 15 percent of the mapped areas, are areas of Amesha loam and Musselshell gravelly and cobbly loams. The Musselshell soils are generally on knolls or terrace breaks adjacent to the drainageways. The Amesha soils are surrounded by Brocko soils. Some of the Brocko soils mapped in the area of Trident are loam below a depth of 15 to 25 inches.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for dryland winter wheat. Some areas are irrigated, and some are used for range. Capability units IIIe-2, dryland, and IIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

BsC—Brocko silt loam, 5 to 9 percent slopes. This sloping and rolling soil is on fans and formed in loess. The area is dissected by well-established drainageways of intermittent streams. This soil has a profile similar to the one described as representative of the series, but in about 40 percent of the area, the material below a depth of 15 to 25 inches is loam.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Musselshell loam, Musselshell gravelly loam, and Amesha silt loam. The Musselshell soils are on low ridges and on sides of drainageways. The Amesha soil is intermingled with the Brocko soil. Also included are small areas of stony loam soils.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for dryland winter wheat and range. Some areas are irrigated. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

BsD—Brocko silt loam, 9 to 25 percent slopes. This moderately steep soil is on fans and terraces near the upper

ends of drainageways in mountainous uplands. This soil has a profile similar to the one described as representative of the series, but in about 40 percent of the area, the material below a depth of 15 to 25 inches is loam.

Included with this soil in mapping, and making up about 30 percent of the acreage, are areas of Musselshell soils. The Brocko soil is on the smoother slopes of the unit, and the included Musselshell soil is on the convex areas along the crests of ridges and on terrace edges. Also included at the upper end of the unit are some 1- to 5-acre areas of a Brocko soil that is 10 to 20 inches deep over bedrock and some ½- to 5-acre areas of cobbly or stony Brocko soils.

The hazards of soil blowing and erosion are severe. Runoff is rapid.

This soil is used for range. Capability unit VIe-1, dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

BtA—Brocko silt loam, wet, 0 to 2 percent slopes. This nearly level soil is on low stream terraces. A seasonal high water table is at a depth of 3 to 5 feet.

Included with this soil in mapping, and making up about 30 percent of the mapped areas, are 2- to 10-acre areas of Mussel loam.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mostly for irrigated alfalfa, spring wheat, and pasture. Capability unit IIIw-1, irrigated; Subirrigated range site, 10- to 14-inch precipitation-zone; windbreak suitability group 2W.

Cabbart Series

The Cabbart series consists of shallow, well-drained soils on sedimentary uplands. These soils formed in material weathered from platy soft siltstone and sandstone of Cretaceous or Tertiary age. Slopes range from 9 to 35 percent. Elevation ranges from 4,200 to 4,800 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown loam about 3 inches thick. The underlying material is very pale brown clay loam. Soft siltstone and sandstone is at a depth of 15 inches.

Permeability is moderate, and the available moisture capacity is very low or low.

Cabbart soils are used mainly for range.

Representative profile of Cabbart loam in an area of Cabbart complex, 9 to 35 percent slopes, 1,300 feet south and 500 feet east of the NW. corner of sec. 25, T. 4 N., R. 1 W.:

A1—0 to 3 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; slightly effervescent; moderately alkaline; clear, smooth boundary.

C1ca—3 to 15 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak, medium, prismatic structure; hard, friable, sticky and slightly plastic, common roots; many fine pores; 5 percent fine gravel; strongly effervescent; common coarse, white (10YR 8/2) lime masses and lime casts on undersides of gravel; moderately alkaline; gradual, wavy boundary.

C2—15 to 60 inches, very pale brown (10YR 7/3) soft sedimentary tertiary siltstone and sandstone that breaks down to sandy clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and slightly plastic; strongly effervescent; strongly alkaline.

The soil ranges from 25 to 35 percent clay. Depth to soft siltstone and sandstone ranges from 10 to 20 inches.

The A1 horizon has a hue of 10YR or 2.5Y, a value of 5 or 6 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The Cca horizon has a hue of 10YR or 2.5Y, a value of 6 or 7 when dry and 4 or 5 when moist, and a chroma of 2 or 3.

CaE—Cabbart complex, 9 to 35 percent slopes. This complex is about 25 percent Cabbart loam, 25 percent Cabbart clay loam, 15 percent Rootel loam and 15 percent Delphill loam. These moderately steep and steep soils are on ridges, sides of eroded terraces, terrace edges, and sides of drainageways. The Rootel and Delphill soils are commonly downslope from the Cabbart soils. The Cabbart loam in this complex has the profile described as representative of the Cabbart series. The Cabbart clay loam has a profile similar to the one described as representative of the Cabbart series, but the surface layer is clay loam. The Rootel loam in this complex has a profile similar to the one described as representative of the Rootel series, but the surface layer is loam.

Included with these soils in mapping, and making up about 15 percent of the mapped areas, are areas of Crago and Musselshell loam and cobbly loam. Also included, and making up about 5 percent, are areas of Rock outcrop or shale outcrop.

The hazard of erosion is severe. Runoff is rapid.

These soils are used for range. Capability unit VIIe-1, dryland; Thin Breaks range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Cheadle Series

The Cheadle series consists of shallow, well-drained soils on side slopes and ridges of hills and mountains. These soils formed in noncalcareous material weathered from igneous and argillite rock. Slopes range from 9 to 35 percent. Elevation ranges from 5,000 to 6,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 60 to 90 days.

In a representative profile the surface layer is dark-brown stony loam about 3 inches thick. The underlying material is dark-brown very channery loam. Fractured igneous bedrock is at a depth of about 8 inches.

Permeability is moderate, and the available moisture capacity is very low.

Cheadle soils are used only for range.

Representative profile of Cheadle stony loam, 9 to 35 percent slopes, 600 feet south and 300 feet west of the NE. corner of sec. 25, T. 7 N., R. 1 W.

A1—0 to 3 inches, dark-brown (7.5YR 4/2) stony loam, dark brown (7.5YR 3/2) moist; moderate, thin, platy structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; many roots; 30 percent channers and 10 percent stones; clear, smooth boundary.

C—3 to 8 inches, dark-brown (7.5YR 4/3) very channery loam, dark brown (7.5YR 3/3) moist; moderate, fine, angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many roots; 40 percent channers and 30 percent stones; abrupt, smooth boundary.

R—8 inches, fine-grained fractured igneous bedrock.

Depth to hard rock ranges from 8 to 20 inches. The soil ranges from 50 to 70 percent coarse fragments of gravel to stone size.

The A1 horizon has a hue of 10YR or 7.5YR and a value of 3 or 4 when dry and 2 or 3 when moist. The C horizon has a hue of 2.5Y to 7.5YR, a value of 4 or 5 when dry and 3 or 4 when moist, and a chroma of 2 or 3.

CdE—Cheadle stony loam, 9 to 35 percent slopes. This hilly steep soil is on ridges and side slopes in 5- to 40-acre areas in the mountainous uplands. Slopes range from 9 to 35 percent, but they are mostly 15 to 30 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of this unit, are areas of Blaine and Rootel cobbly loams. Also included, and making up about 15 percent, are areas of Rock outcrop and some soils that are less than 8 inches deep over bedrock. Rock outcrop and the very shallow soils are on ridgetops and points of hills. The Blaine and Rootel soils are on low side slopes and foot slopes and in concave, saddlelike areas.

The hazard of erosion is very severe. Runoff is rapid or very rapid.

This soil is used for range. Capability unit VIe-1, dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4.

Chinook Series

The Chinook series consists of deep, well-drained soils on terraces, fans, and rolling and undulating uplands. These soils formed in alluvium and windblown sediment. Slopes range from 1 to 35 percent. Elevation ranges from 3,700 to 4,100 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown sandy loam about 8 inches thick. The subsoil, about 11 inches thick, is brown and light yellowish-brown sandy loam and gravelly sandy loam. The underlying material is light-gray, white, and very pale brown stratified gravelly sandy loam and gravelly sandy clay loam.

Permeability is moderately rapid, and the available moisture capacity is moderate.

Chinook soils are used for irrigated and dryland crops and range.

Representative profile of Chinook sandy loam, 1 to 4 percent slopes, 1,150 feet east and 350 feet south of the NW. corner of sec. 26, T. 7 N., R. 2 E.:

Ap—0 to 8 inches, grayish-brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) moist; weak, blocky structure; soft, very friable, slightly sticky and nonplastic; clear, smooth boundary.

B2—8 to 14 inches, brown (10YR 5/3) sandy loam, dark grayish brown (10YR 4/2) moist; weak, coarse, blocky structure; soft, very friable, slightly sticky and nonplastic; common fine and very fine, continuous, tubular pores; clear, smooth boundary.

B3ca—14 to 19 inches, light yellowish-brown (2.5Y 6/3) gravelly sandy loam, light olive brown (2.5Y 5/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; common fine and very fine pores; 20 percent gravel; strongly effervescent; lime coats and casts on undersides of gravel; clear, wavy boundary.

C1ca—19 to 34 inches, light-gray (2.5Y 7/2) gravelly sandy loam, light brownish gray (2.5Y 6/2) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; 20 percent gravel; violently effervescent; many fine, distinct lime spots and nodules and lime casts on undersides of gravel; diffuse, smooth boundary.

C2ca—34 to 42 inches, white (10YR 8/2) gravelly sandy clay loam, pale brown (10YR 6/3) moist; massive; hard, very friable, slightly sticky and slightly plastic; 20 percent gravel; violently effervescent; many fine, distinct lime splotches and nodules and lime coatings on undersides of gravel; diffuse, smooth boundary.

C3—42 to 60 inches, very pale brown (10YR 7/3) gravelly sandy clay loam, pale brown (10YR 6/3) moist; massive; hard, friable, sticky and slightly plastic; 20 percent gravel; violently effervescent.

Depth to a horizon of calcium carbonate accumulation ranges from 11 to 18 inches. Between depths of 10 and 40 inches the soil is mainly sandy loam and gravelly sandy loam, but it is thinly stratified with loam, loamy sand, and gravelly loamy sand. The soil ranges from 5 to 35 percent coarse fragments of gravel and cobble size.

The A horizon has a hue of 10YR or 2.5Y and a chroma of 2 or 3. The B horizon has a value of 5 or 6 when dry and a chroma of 2 or 3. It has weak to moderate, prismatic structure parting to weak or moderate, blocky. The Cca horizon has a hue of 10YR or 2.5Y, a value of 6 to 8 when dry and 4 to 6 when moist, and a chroma of 2 to 5.

ChB—Chinook sandy loam, 1 to 4 percent slopes. This nearly level and gently sloping or gently undulating soil is on fans and terraces. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are 1- to 3-acre areas of Amesha sandy loam. Also included are areas of a Chinook soil that is underlain by sandy clay loam.

The hazard of soil blowing is severe. Runoff is very slow.

This soil is used mainly for irrigated alfalfa, sugar beets, and potatoes. Capability units IIIe-2, dryland, and IIe-1, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

ChC—Chinook sandy loam, 4 to 9 percent slopes. This gently sloping and sloping soil is on fans and terraces dissected by shallow drainageways.

Included with this soil in mapping are some areas of Amesha soils and some areas of gravelly and cobbly loams near drainageways.

The hazard of soil blowing is severe. Runoff is very low.

This soil is used mainly for irrigated alfalfa, sugar beets, and potatoes. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

CmC—Chinook-Crago loamy sands, 1 to 9 percent slopes. This complex is about 50 percent Chinook loamy sand and 40 percent Crago loamy sand. These nearly level to rolling soils are on eroded stream terraces. The Chinook soil is on the smoother and less sloping areas, and the Crago soil is on convex areas. The Chinook and Crago soils in this complex have profiles similar to those described as representative of their respective series, but the surface layer is loamy sand, and the Crago soil has a darker colored surface layer and in places is gravelly or cobbly.

Included with these soils in mapping, and making up about 10 percent of the mapped areas, are areas of a Chinook soil that is underlain by sandy clay loam.

The hazard of soil blowing is severe. Runoff is very slow.

These soils are used mainly for pasture. Some areas are used for irrigated crops. Capability units VIe-1, dryland, and IIIe-3, irrigated; Sands range site, 10- to 14-inch precipitation zone; Chinook loamy sand in windbreak suitability group 2M; Crago loamy sand in windbreak suitability group 3M.

CnC—Chinook-Crago complex, 5 to 9 percent slopes. This complex is about 40 percent Chinook sandy loam and Chinook cobbly sandy loam and 40 percent Crago cobbly loam and Crago cobbly sandy loam. These sloping or rolling soils are on fans. About 60 percent of the surface of this complex is cobbly. The Chinook and Crago soils in this complex have profiles similar to those described as representative of their respective series, but in places the surface layer is cobbly loam. The Chinook soils are on the lower

parts of fans in smooth, slightly concave areas. The Crago soils are mostly on the upper, convex parts of fans. Crago very cobbly soils make up about 10 percent of the upper fan areas.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of Amesha sandy loam.

The hazard of soil blowing is severe on the sandy loam soils and moderate on the cobbly soils. Runoff is very slow.

These soils are used for irrigated and dryland crops and range. Capability units IIIe-4, dryland, and IIIe-3, irrigated; Chinook sandy loam in Sandy range site, 10- to 14-inch precipitation zone; and in windbreak suitability group 2M; Crago cobbly sandy loam in Limy range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3M.

CnE—Chinook-Crago complex, 9 to 35 percent slopes. This complex is about 20 percent Chinook sandy loam, 20 percent Chinook cobbly sandy loam, 30 percent Crago cobbly sandy loam, and 10 percent Crago very cobbly sandy loam. These hilly and steep soils are on eroded remnants of terraces. The Chinook and Crago soils in this complex have profiles similar to those described as representative of their respective series, but in places the Chinook soils are cobbly, in places the Crago soils are very cobbly, and in places the Chinook soils have a thinner surface layer and subsoil. The Crago soils are mostly on ridgetops, knolls, and the steeper slopes. The Chinook soils are on the lower, smoother slopes. Both soils are in 5- to 20-acre areas.

Included with these soils in mapping are small areas of Amesha and Scravo soils that make up about 10 percent of the mapped areas.

The hazard of soil blowing is moderate to high. Runoff is slow and very slow.

These soils are used mainly for range. Capability unit VIe-1, dryland; windbreak suitability group 4; Chinook sandy loam in Sandy range site, 10- to 14-inch precipitation zone; Crago cobbly sandy loam in Limy range site, 10- to 14-inch precipitation zone.

Chinook Variant

The Chinook variant consists of deep, well-drained soils on stream terraces. These soils formed in calcareous sandy loam and gravelly sandy loam alluvium. Slopes range from 1 to 4 percent. Elevation ranges from 3,700 to 4,100 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown sandy loam about 11 inches thick. The subsoil, about 7 inches thick is light brownish-gray sandy loam and gravelly sandy loam and light-gray very gravelly sandy clay loam. Below this, to a depth of 60 inches, it is light-gray very gravelly loamy sand.

Permeability is moderately rapid, and the available moisture capacity is mostly low.

Chinook variant soils are used mainly for irrigated crops and range.

Representative profile of Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes, in a cultivated area, 1,100 feet north and 100 feet west of the SE. corner of sec. 27, T. 5 N., R. 2 E.:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak, blocky structure; slightly hard, very friable, slightly sticky and nonplastic; mostly noneffervescent, but a few weakly effervescent spots; clear, smooth boundary.

A1—5 to 11 inches, grayish-brown (2.5Y 5/2) sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak, blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few fine pores; abrupt, smooth boundary.

B—11 to 18 inches, light brownish-gray (10YR 6/3) sandy loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; slightly hard, very friable, slightly sticky and nonplastic; few fine pores; clear, smooth boundary.

C1—18 to 23 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, medium and coarse, angular blocky structure; hard, very friable, slightly sticky and nonplastic; many fine pores; mostly noneffervescent, but a few strongly effervescent spots; clear, smooth boundary.

IIC2ca—23 to 27 inches, light-gray (10YR 7/2) very gravelly sandy clay loam, grayish brown (10YR 5/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; 55 percent gravel; violently effervescent; lime casts on undersides of gravel; gradual, smooth boundary.

IIC3ca—27 to 33 inches, light brownish-gray (2.5Y 6/2) gravelly sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; 25 percent gravel; violently effervescent; patchy lime casts on gravel; gradual, smooth boundary.

IIIC—33 to 60 inches, light-gray (10YR 7/2) very gravelly loamy sand, grayish brown (10YR 5/2) moist; massive; loose, nonsticky and nonplastic; 65 percent gravel; strongly effervescent; patchy lime casts on undersides of gravel.

Depth to very gravelly loamy sand ranges from 20 to 35 inches. The solum ranges from 10 to 18 inches in thickness. Hue is 10YR or 2.5Y throughout.

The B horizon has a value of 5 or 6 when dry and chroma of 2 or 3. It has prismatic or blocky structure.

CkB—Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes. This nearly level and gently sloping soil is on stream terraces.

Included with this soil in mapping are small areas of Amesha sandy loam, Crago gravelly soils, and Scravo gravelly soils. The Crago and Scravo soils are on knolls, along drainageways, and on terrace edges. The Amesha soils make up about 20 percent, and Crago and Scravo soils about 10 percent, of the mapping unit. Also included are small areas of soils that have a seasonal high water table as a result of seepage from main irrigation laterals.

The hazard of soil blowing is severe. Runoff is very slow.

This soil is used mainly for irrigated crops and range. Capability units IVs-2, dryland, and IIIe-3, irrigated; Sandy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Crago Series

The Crago series consists of deep, well-drained soils on high terraces, broad fans, and foot slopes dissected by drainageways. These soils formed in mixed, strongly calcareous gravelly and cobbly alluvium derived mainly from limestone. Slopes range from 4 to 35 percent. Elevation ranges from 3,700 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray cobbly loam about 4 inches thick. The underlying material is white and very pale brown gravelly

loam, very gravelly sandy loam, and very gravelly loamy sand. Pebbles and cobbles are coated with thick lime casts.

Permeability is moderate to a depth of about 36 inches and rapid below that depth. The available moisture capacity is mostly low.

Crago soils are used mainly for range. Some areas mapped with other cultivated soils are used for crops.

Representative profile of Crago cobbly loam in an area of Crago complex, 4 to 9 percent slopes, 700 feet west and 400 feet north of the SE. corner of sec. 14, T. 8 N., R. 2 E.:

A1—0 to 4 inches, light brownish-gray (10YR 6/2) cobbly loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure separating to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; 20 percent gravel and cobbles; strongly effervescent; clear, smooth boundary.

C1ca—4 to 27 inches, white (10YR 8/2) gravelly loam, light brownish gray (10YR 6/2) moist; weak, medium, blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; about 50 percent gravel and cobbles; violently effervescent; common medium, distinct splotches of lime and thick lime casts on sides and undersides of gravel and cobbles; gradual, wavy boundary.

C2ca—27 to 36 inches, very pale brown (10YR 7/3) very gravelly sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; about 65 percent gravel and cobbles; violently effervescent; moderately thick lime casts on undersides of gravel and cobbles; gradual, wavy boundary.

IIC3—36 to 60 inches, very pale brown (10YR 7/3) very gravelly loamy sand, brown (10YR 5/3) moist; massive; loose, nonsticky and nonplastic; about 65 percent gravel and cobbles; strongly effervescent; thin lime casts on the undersides of gravel and cobbles.

Between depths of 10 and 40 inches, the soil ranges from 35 to 60 percent gravel and cobbles. Depth to very gravelly sandy material is 30 inches or more. The soil has a hue of 2.5Y or 10YR throughout.

The A1 horizon has a value of 5 or 6 when dry and 4 or 5 when moist and a chroma of 2 or 3. The Cca horizon has a value of 6 to 8 when dry and 5 or 6 when moist.

CrC—Crago complex, 4 to 9 percent slopes. This complex is about 55 percent Crago cobbly loam and Crago gravelly loam and 25 percent Musselshell gravelly loam and Musselshell cobbly loam. These gently sloping and sloping soils are on alluvial fans at the bases of steeper landscapes. Slopes are 4 to 9 percent, are smooth, and range from 200 to 700 feet long. The Crago cobbly loam in this complex has the profile described as representative of the Crago series. The Crago gravelly loam and the Musselshell soils in this complex have profiles similar to the ones described as representative of their respective series, but the Crago soil has a surface layer of gravelly loam, and in places the Musselshell soils are cobbly. The Crago soils are generally at the tops of fans and on the more convex parts of fans. The Musselshell soils are below the Crago soils on the less sloping, smoother parts of the complex. The highest proportion of gravel and cobbles is along the apex of the fans. The Crago soils are in areas 20 acres or less in size, and the Musselshell soils are in areas of 10 acres or less.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of Thess loam and Thess gravelly loam.

The hazard of soil blowing is moderate or severe. Runoff is medium.

These soils are used for some irrigated crops, dryland winter wheat, and range. Capability units IVs-2, dryland, and IIIe-3, irrigated; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Delphill Series

The Delphill series consists of moderately deep, well-drained soils on side slopes and smooth ridges in the sedimentary uplands. These soils formed in material weathered from soft siltstone and loamy to clayey soft shale of Cretaceous or Tertiary age. Slopes range from 2 to 20 percent. Elevation ranges from 4,200 to 4,800 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is light brownish-gray loam about 4 inches thick. The underlying material is pale-brown and very pale brown, strongly calcareous clay loam. Interbedded soft siltstone and loamy shale are at a depth of about 35 inches.

Permeability is moderate, and the available moisture capacity is low or moderate.

Delphill soils are used for dryland crops and range.

Representative profile of Delphill loam in an area of Delphill-Abor complex, 5 to 20 percent slopes, 1,600 feet east and 180 feet north of the SE. corner of sec. 25, T. 4 N., R. 1 W.

A1—0 to 4 inches, light brownish-gray (10YR 6/2) loam, brown (10YR 4/3) moist; weak, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; strongly effervescent; strongly alkaline; clear, smooth boundary.

C1ca—4 to 19 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; moderate, coarse, prismatic structure; hard, friable, sticky and slightly plastic; common roots; many fine pores; strongly effervescent; common medium, distinct, white (10YR 8/2) masses of segregated lime; strongly alkaline; clear, smooth boundary.

C2ca—19 to 35 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure; hard, friable, sticky and slightly plastic; few roots; many fine pores; strongly effervescent; common medium, distinct, white (10YR 8/2) masses of segregated lime; strongly alkaline; gradual, smooth boundary.

C3—35 to 60 inches, very pale brown (10YR 7/3) interbedded soft siltstone and loamy shale, brown (10YR 5/3) moist; massive; very hard, firm, sticky and plastic; few seams and patches of salts to a depth of 50 inches, many seams and patches of salts below.

Depth to soft siltstone or loamy or clayey shale ranges from 20 to 40 inches. The soil has a hue of 2.5Y or 10YR throughout.

The A horizon has a value of 5 or 6 when dry and a chroma of 2 or 3. The Cca horizon has a value of 6 or 7 when dry and 4 or 5 when moist and a chroma of 2 or 3.

DeB—Delphill loam, 2 to 5 percent slopes. This gently sloping soil is on smooth sedimentary uplands. Slopes are 100 to 500 feet long. This soil has a profile similar to the one described as representative of the series, but it formed in transported material rather than in residuum, and the underlying beds are mostly clay shale.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Abor silty clay and Mussel loam. The Mussel soil is in concave areas, and the Abor soil is on convex areas within areas of Delphill soils.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used for dryland winter wheat and range. Capability unit IIIe-2, dryland; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

DhD—Delphill-Abor complex, 5 to 20 percent slopes. This complex is about 40 percent Delphill loam and 30 percent Abor silty clay. These rolling to steep soils are on

sedimentary uplands. The Delphill soil in this complex has the profile described as representative of the Delphill series. The Delphill soil is along the top parts of mounds or ridges, and the Abor soil is on side slopes and in some concave areas.

Included with these soils in mapping, and making up about 30 percent of the mapped areas, are areas of Cabbart loam, shale outcrop, and some saline-alkali affected soils. The Cabbart soil is intermingled with the Delphill soil. Soils that are shallow over shale and areas of shale outcrop are generally below the crests of knolls. Saline-alkali affected soils are in concave areas and drainageways.

The hazards of soil blowing and erosion are severe. Runoff is rapid.

These soils are used for range. Capability unit VIe-1, dryland; Delphill soil in Silty range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 2M; Abor soil in Clayey range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3M.

Dominic Series

The Dominic series consists of deep, somewhat excessively drained soils on alluvial fans and terraces. These soils formed in mixed, noncalcareous very gravelly and cobbly sandy alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is dark grayish-brown very cobbly sandy loam about 12 inches thick. The underlying material is light olive-brown, stratified very gravelly loamy sand and very gravelly sandy loam to a depth of 60 inches or more.

Permeability is rapid, and the available moisture capacity is mostly very low. A seasonal high water table is at a depth of 5 to 10 feet.

Dominic soils are used mainly for range.

Representative profile of Dominic very cobbly sandy loam in an area of Dominic soils (0 to 2 percent slopes), 1,700 feet south and 550 feet west of the center of sec. 36, T. 9 N., R. 1 W.:

A11—0 to 7 inches, dark grayish-brown (10YR 4/2) very cobbly sandy loam, very dark brown (10YR 2/2) moist; strong, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; clear, smooth boundary.

A12—7 to 12 inches, dark grayish-brown (10YR 4/2) very cobbly sandy loam, very dark dark grayish brown (10YR 3/2) moist; weak, fine, blocky structure; soft, very friable, slightly sticky and nonplastic; gradual, wavy boundary.

C1—12 to 40 inches, light olive-brown (2.5Y 5/4) very gravelly loamy sand, olive brown (2.5Y 4/3) moist; loose, nonsticky and nonplastic; 60 to 75 percent gravel and cobbles; clear, wavy boundary.

C2—40 to 50 inches, light olive-brown (2.5Y 5/3) very gravelly sandy loam, olive brown (2.5Y 4/3) moist; loose, nonsticky and nonplastic; 60 to 75 percent gravel and cobbles; noncalcareous; thin lime coatings under some cobbles; clear, wavy boundary.

C3—50 to 60 inches, light olive-brown (2.5Y 5/3) very gravelly loamy sand, olive brown (2.5Y 4/3) moist; loose; 60 to 75 percent gravel and cobbles.

The soil ranges from 60 to 75 percent cobbles and gravel throughout.

The A horizon ranges from 10 to 16 inches in thickness. It has a hue of 10YR or 2.5Y, a value of 4 or 5 when dry and 2 or 3 when moist, and a chroma of 2 or 3. The C horizon is stratified very gravelly or cobbly sandy loam, loamy sand, and sand.

Do—Dominic soils (0 to 2 percent slopes). These nearly level soils are on alluvial fans and terraces that are dissected at 50- to 500-foot intervals by shallow drainageways. This mapping unit is about 50 percent Dominic very gravelly loam and very cobbly sandy loam and 30 percent Dominic loam. The Dominic very cobbly sandy loam in this unit has the profile described as representative of the Dominic series. The Dominic very gravelly loam and the Dominic loam have profiles similar to the one described as representative of the Dominic series, but the surface layer is very gravelly loam and loam. The Dominic very gravelly loam and very cobbly sandy loam are on low, convex areas and along drainageways. The Dominic loam is on the flat to slightly concave areas.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are small areas of a loam soil that is 20 to 40 inches deep over sandy gravel and small areas of Fairdale loam.

The hazard of erosion is slight. Runoff is slow. Some areas near streams are flooded in some years.

Some areas of loamy soils are used for irrigated pasture. Most areas of cobbly to very cobbly soils are used for range. Capability unit VIs-1, dryland; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Ess Series

The Ess series consists of deep, well-drained soils on mountain side slopes. These soils formed in noncalcareous, very cobbly and stony colluvial and alluvial materials weathered from igneous rock. Slopes range from 35 to 60 percent. Elevation ranges from 5,000 to 6,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 60 to 90 days.

In a representative profile the surface layer is very dark grayish-brown stony loam about 10 inches thick. The subsoil, about 40 inches thick, is grayish-brown and light yellowish-brown very stony clay loam. The underlying material is light yellowish-brown very stony loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is low.

Ess soils are used only for range.

Representative profile of Ess stony loam in an area of Ess-Cheadle complex, 35 to 60 percent slopes, 500 feet west and 750 feet south of the NE. corner of sec. 25, T. 7 N., R. 1 E.:

A1—0 to 10 inches, very dark grayish-brown (10YR 3/2) stony loam, black (10YR 2/1) moist; moderate, thin, platy structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and nonplastic; clear, wavy boundary.

B21t—10 to 33 inches, grayish-brown (10YR 5/2) very stony clay loam, brown (10YR 4/3) moist; weak, fine, angular blocky structure; hard, friable, sticky and slightly plastic; patchy clay films on vertical and horizontal surfaces of peds and on rock fragments; 70 percent stones, cobbles, and gravel; gradual, wavy boundary.

B22t—33 to 50 inches, light yellowish-brown (10YR 6/4) very stony clay loam, olive brown (10YR 4/4) moist; moderate, medium, angular blocky structure; hard, friable, sticky and slightly plastic; thin continuous clay films on vertical surfaces of peds and patchy clay films on horizontal surfaces of peds, some clay films on rock fragments; 70 percent stones, cobbles, and gravel; gradual, wavy boundary.

C—50 to 60 inches, light yellowish-brown (2.5Y 6/3) very stony loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; lime coatings on undersides of some rock fragments.

Depth to hard rock ranges from 40 to more than 60 inches. The solum ranges from 30 to 50 inches in thickness.

The A1 horizon ranges from 10 to 14 inches in thickness. It has a hue of 10YR or 7.5YR, a value of 3 or 4 when dry, and a chroma of 1 or 2. The B2t horizon has a hue of 10YR or 7.5YR, a value of 3 or 4 when moist, and a chroma of 2 to 4. The C horizon has a hue of 2.5Y or 10YR, a value of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 to 4. The B2t and C horizons range from 50 to 80 percent stones, cobbles, and gravel.

EcF—Ess-Cheadle complex, 35 to 60 percent slopes. This complex is about 50 percent Ess stony loam and Ess very stony loam and 40 percent Cheadle cobbly loam and stony loam. These very steep soils are on mountainous uplands at elevations of more than 5,000 feet. The steep Ess soils are on mountainsides. The Cheadle soils are on ridges and some downslope areas. The Ess stony loam in this complex has the profile described as representative of the Ess series. The Ess very stony loam is similar, but the surface layer is more than 20 percent stones. The Cheadle soils in this complex have profiles similar to the one described as representative of the Cheadle series, but in places the surface layer is cobbly loam.

Included with these soils in mapping, and making up about 10 percent of the mapped areas, are areas of Rock outcrop, most commonly on or near ridgetops. The very stony areas are most commonly on the lower part of the slope.

The hazard of erosion is severe. Runoff is rapid.

These soils are used only for range. Capability unit VIe-1, dryland; windbreak suitability group 4; Ess very stony loam in Stony range site, 15- to 19-inch precipitation zone; Cheadle stony loam in Shallow range site, 15- to 19-inch precipitation zone.

Fairdale Series

The Fairdale series consists of deep, somewhat poorly drained soils on stream terraces. These soils formed in mixed, calcareous alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown silt loam about 7 inches thick. The underlying material is mostly gray stratified silt loam and loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is high. A seasonal high water table is at a depth of 36 to 60 inches.

Fairdale soils are used mainly for irrigated alfalfa, small grains, and tame pasture. Some areas are used for range.

Representative profile of Fairdale silt loam (0 to 2 percent slopes), 1,700 feet west and 100 feet north of the SE. corner of sec. 29, T. 7 N., R. 3 E.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure parting to strong, medium and fine, granular; hard, very friable, slightly sticky and slightly plastic; weakly effervescent; abrupt, smooth boundary.

C1—7 to 9 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; common, fine, reddish-yellow mottles; weak, medium and coarse, blocky structure; hard, very friable, slightly sticky and slightly plastic; common fine pores; strongly effervescent; abrupt, smooth boundary.

Ab—9 to 15 inches, dark-gray (10YR 4/2) silt loam, very dark gray (10YR 3/1) moist; few, fine, distinct, reddish-yellow mottles; weak, medium, prismatic structure parting to moderate, medium and fine, angular blocky; hard, very friable, slightly sticky and slightly plastic; common fine pores; strongly effervescent; abrupt, smooth boundary.

C2—15 to 30 inches, gray (2.5Y 6/1) loam, dark gray (2.5Y 4/1) moist; few, fine, distinct, reddish-yellow mottles; weak, medium, prismatic structure parting to weak, medium, blocky; hard, friable, slightly sticky and slightly plastic; common fine pores; strongly effervescent; clear, smooth boundary.

C3—30 to 60 inches, gray (2.5Y 5/1) silt loam, dark gray (2.5Y 4/1) moist; few, fine, distinct, reddish-yellow mottles; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; common threads of lime.

Depth to sandy gravel or sand is 50 inches or more.

The A horizon ranges from 7 to 20 inches in thickness. It has a value of 4 or 5 when dry and 2 or 3 when moist and a chroma of 1 or 2. The C horizon has a hue of 10YR or 2.5Y, a value of 4 to 6 when dry and 3 or 4 when moist, and a chroma of 1 or 2. It is mainly weakly calcareous to strongly calcareous, but some horizons are noncalcareous in places. Reddish-yellow to brown mottles are few to common.

Fa—Fairdale silt loam (0 to 2 percent slopes). This nearly level soil is on low stream terraces along the Missouri River, Deep Creek, Crow Creek, and other major tributaries to the Missouri River. The landscape is dissected in a few places by shallow drainageways of intermittent streams. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Villy silty clay loam and a soil that is similar to Havre loam but that has a seasonal high water table at a depth of 36 to 60 inches. The Villy soil is in drainageways and depressions. The soil similar to the Havre soil is within areas of Fairdale soils. Included soils make up about 20 percent of the mapping unit.

The hazard of erosion is slight. Runoff is medium.

This soil is used for irrigated alfalfa, spring wheat, pasture, and range. Capability unit IIIw-1, irrigated; Subirrigated range site, 10- to 14-inch precipitation zone; windbreak suitability group 2W.

Fb—Fairdale-Lothair silty clays (0 to 2 percent slopes). This complex is about 40 percent Fairdale silty clay and 40 percent Lothair silty clay. In some areas the Lothair soil makes up a larger percentage of the mapping unit than the Fairdale soil. These nearly level soils are on low stream terraces and flood plains and have a seasonal high water table at a depth of 36 to 60 inches. The Fairdale soil in this complex has a profile similar to the one described as representative of the Fairdale series, but the surface layer is silty clay 10 to 15 inches thick. The Lothair soil in this complex has a profile similar to the one described as representative of the Lothair series, but it has rust-brown mottles below a depth of 20 inches. Also, it has a seasonal high water table at a depth of 36 to 60 inches.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of 5 acres or less of Villy soils and other poorly drained soils in shallow depressions and low, channeled areas.

The hazard of erosion is slight. Runoff is medium.

These soils are used for irrigated alfalfa, pasture, and spring wheat. Capability unit IIIw-1, irrigated; Subirrigated range site, 10- to 14-inch precipitation zone; windbreak suitability group 2W.

Fluvaquentic Haplaquolls

Fd—Fluvaquentic Haplaquolls (0 to 2 percent slopes). These are dark-colored, poorly drained soils mainly along flowing streams, but also in some isolated small areas scattered throughout the survey area. The water table is at or near the surface most of the year. These soils range from loam to clay and are generally more than 40 inches deep to sandy gravel. The surface is mostly irregular because of old and new watercourses that traverse the unit.

The hazard of erosion is none to slight, and runoff is very slow.

This unit is used only for grazing. Capability unit VIw-1, dryland; Wetland range site, 10- to 19-inch precipitation zone; windbreak suitability group 4.

Havre Series

The Havre series consists of deep, well drained and moderately well drained soils on stream terraces. These soils formed in loamy, mixed, calcareous alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray loam about 7 inches thick. The underlying material is light brownish-gray, grayish-brown, light yellowish-brown, and light-gray stratified loam, sandy loam, and some thin strata of loamy sand.

Permeability is moderate, and the available moisture capacity is high. Local areas are subject to flooding.

Havre soils are used mostly for irrigated and dryland crops.

Representative profile of Havre loam (0 to 2 percent slopes), 1,000 feet northwest of the center of sec. 10, T. 4 N., R. 1 E.:

Ap—0 to 7 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak, medium, blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; strongly effervescent; abrupt, smooth boundary.

C1—7 to 20 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine pores; 2 percent fine gravel; strongly effervescent; abrupt, smooth boundary.

C2—20 to 24 inches, light brownish-gray (2.5Y 6/2) loamy sand, dark grayish brown (2.5Y 4/2) moist; single grained; loose; 5 percent gravel; slightly effervescent; abrupt, smooth boundary.

C3—24 to 36 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; slightly effervescent; gradual, smooth boundary.

C4—36 to 50 inches, light yellowish-brown (2.5Y 6/3) loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 3 percent gravel; strongly effervescent; gradual, smooth boundary.

C5—50 to 60 inches, light-gray (2.5Y 7/2) gravelly sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 20 percent fine gravel; violently effervescent; gravel coated with lime.

Some thin, dark-brown to black layers and some thin gravelly layers occur in places. The soil is weakly calcareous to moderately calcareous between depths of 10 and 40 inches.

The A horizon has a hue of 10YR or 2.5Y, a value of 5 or 6 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The C horizon has a hue of 10YR or 2.5Y, a value of 6 or 7 when dry and 4 or 5 when moist, and a chroma of 2 or 3.

Ha—Havre loam (0 to 2 percent slopes). This nearly level soil is on low stream terraces along the Missouri River and its tributaries. The surface layer is mainly loam, but in small areas it is clay loam and silty clay loam.

Included with this soil in mapping are 1- to 5-acre areas of Mussel loam, Brocko silt loam, and a soil that is similar to this Havre soil but that is about 30 inches deep over sandy gravel. Included soils make up about 30 percent of the mapping unit.

The hazard of soil blowing is moderate. Runoff is medium. In places a seasonal high water table is at a depth of 5 to 10 feet.

This soil is used mostly for irrigated and dryland crops. Capability units IIIe-2, dryland, and IIc-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Hilger Series

The Hilger series consists of deep, well-drained soils on fans and mountain foot slopes. These soils formed in calcareous cobbly and stony colluvium. Slopes range from 8 to 25 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 90 to 105 days.

In a representative profile the surface layer is very dark grayish-brown extremely stony loam about 3 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown and brown very stony clay. The underlying material is light-gray, white, and pale-brown, mostly very stony and very cobbly clay loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is low or moderate.

Hilger soils are used only for range.

Representative profile of Hilger extremely stony loam, 8 to 25 percent slopes, 450 feet west and 450 feet south of the center of sec. 28, T. 9 N., R. 1 W.:

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) extremely stony loam, very dark grayish brown (10YR 3/2) moist; weak, medium, platy structure parting to moderate, fine, granular; slightly hard, friable, sticky and slightly plastic; 55 percent stones and cobbles; clear, smooth boundary.

B21t—3 to 6 inches, dark grayish-brown (10YR 4/2) very stony clay, dark brown (10YR 3/3) moist; moderate, medium and fine, angular blocky structure; very hard, firm, very sticky and very plastic; 40 percent stones and cobbles; clear, wavy boundary.

B22t—6 to 11 inches, brown (10YR 5/3) very stony clay, dark brown (10YR 4/3) moist; weak, medium and fine, angular blocky structure; hard, friable, very sticky and plastic; 40 percent stones and cobbles; abrupt, wavy boundary.

C1ca—11 to 16 inches, light-gray (10YR 7/2) very stony clay loam, grayish brown (10YR 5/2) moist; weak, fine, angular blocky structure; hard, friable, sticky and plastic; 55 percent stones and cobbles; violently effervescent; few nodules and splotches of lime; gradual, wavy boundary.

C2ca—16 to 28 inches, light-gray and white (10YR 7/2 and 8/2) very stony clay loam, light brownish gray (10YR 6/2) moist; massive; hard, friable, sticky and plastic; 60 percent stones and cobbles; violently effervescent; many large nodules and splotches of lime; gradual, wavy boundary.

C3—28 to 60 inches, pale-brown (10YR 6/3) very cobbly clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and plastic; 65 percent cobbles and stones; strongly effervescent to violently effervescent; many nodules and splotches of lime.

These soils range from 35 to 50 percent cobbles and stones in the A and B horizons and from 50 to 65 percent in the C horizon.

The A1 horizon ranges from 3 to 6 inches in thickness. It has a hue of 10YR or 7.5YR, a value of 3 to 5 when dry and 2 or 3 when moist, and a chroma of 2 or 3. The B horizon has a hue of 10YR or 7.5YR, a

value of 4 or 5 when dry and 3 or 4 when moist, and a chroma of 2 to 4. The Cca horizon has a hue of 2.5Y or 10YR, a value of 7 or 8 when dry and 5 or 6 when moist, and a chroma of 2 or 3.

HgE—Hilger extremely stony loam, 8 to 25 percent slopes. This sloping to steep soil is on fans, mounds, and foot slopes below mountains. The fans are long and broad and in many places are dissected by drainageways of intermittent streams. The foot slopes are mostly smooth and have rounded tops. The Hilger loam in about 20 percent of the area of this mapping unit has no stones on the surface. Most of the stones in other parts of the unit are on mounds and ridges.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Crago, Musselshell, and Sappington gravelly or stony loams. These included soils are mostly on lower foot slopes or along drainageways.

The hazard of erosion is moderate to severe. Runoff is medium to rapid.

This soil is used only for range. Capability unit VIs-1, dryland; Stony range site, 15- to 19-inch precipitation zone; windbreak suitability group 4.

Lake Creek Series

The Lake Creek series consists of moderately deep, well-drained soils on uplands along drainageways and on mountain side slopes. These soils formed in material weathered from gray argillite of the Belt formation. Slopes range from 20 to 50 percent. Elevation ranges from 4,500 to 6,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is less than 90 days.

In a representative profile the surface layer, under a 2-inch organic mat of forest litter, is light brownish-gray channery loam about 9 inches thick. The subsoil, about 11 inches thick, is pale-brown channery loam. The underlying material is light-gray channery and very channery loam. Argillite bedrock is at a depth of about 35 inches.

Permeability is moderate, and the available moisture capacity is low or very low.

Lake Creek soils are used mainly for woodland. Some areas are used for woodland grazing and wildlife habitat.

Representative profile of Lake Creek channery loam, 20 to 50 percent slopes, 700 feet southwest of the E. quarter corner of sec. 25, T. 8 N., R. 3 E.:

O1—2 inches to 0, organic mat consisting of forest litter of decomposed pine needles, leaves, roots, branches, and some wood.

A2—0 to 9 inches, light brownish-gray (10YR 6/2) channery loam, dark grayish brown (10YR 4/2) moist; weak to moderate, medium and fine, subangular blocky structure parting to moderate, thin, platy; slightly hard, very friable, slightly sticky and slightly plastic; common fine tubular pores; many roots; bleached silt and sand grains coating peds; clear, smooth boundary.

B2t—9 to 20 inches, pale-brown (10YR 6/3 and some 10YR 6/2) channery heavy loam, brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and slightly plastic; many roots; common fine pores; bleached silt and sand grain coating peds; thin patchy clay films on undersides of some channers and in some pores; 40 percent fine angular gravel; gradual, smooth boundary.

C1ca—20 to 24 inches, light-gray (10YR 6/1) channery loam, gray (10YR 5/1) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; gradual, smooth boundary.

C2ca—24 to 35 inches, light-gray (5Y 7/2) very channery loam, light olive gray (5Y 6/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strongly effervescent; channers coated with lime; abrupt, wavy boundary.

R—35 inches, argillite bedrock.

Depth to bedrock ranges from 20 to 40 inches. The solum ranges from 15 to 25 inches in thickness. Between a depth of 10 inches and bedrock, the soils range from 35 to 55 percent channers.

The A2 horizon has a hue of 2.5Y or 10YR and a value of 6 or 7 when dry and 3 or 4 when moist. The B horizon has a hue of 2.5Y or 10YR, a value of 5 or 6 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The Cca horizon, where present, has a hue of 2.5Y or 5Y and a chroma of 2 or 3.

LaF—Lake Creek channery loam, 20 to 50 percent slopes. This steep and very steep soil is mostly on north-facing slopes.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are small areas of Nielsen channery and very channery loam and Rock outcrop. The Nielsen soils and Rock outcrop are commonly on ridges and points of hills.

The hazard of erosion is severe. Runoff is rapid.

This soil is used mainly as woodland. It supports a dense stand of Douglas-fir. Mixed with this, making up about 5 percent of the stand, are associated species, mainly lodgepole pine and aspen. The woodland site index is 40 to 50 for the Douglas-fir, based on Brickell curves and a 50-year base. There are limitations to logging on slopes of more than 30 percent. Capability unit VIe-1, dryland; range site and windbreak suitability group not assigned.

Loberg Series

The Loberg series consists of deep, well-drained soils on mountain foot slopes and fans. These soils formed in loamy material derived from mixed igneous and sedimentary rocks. Slopes range from 10 to 35 percent. Elevation ranges from 5,000 to 6,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free season is less than 90 days.

A representative profile has a 3-inch mat of forest litter on the surface. The surface layer is light-gray very stony loam about 4 inches thick. The next layer is grayish-brown and light brownish-gray channery clay loam about 4 inches thick. The subsoil, about 24 inches thick, is light olive-brown channery clay loam in the upper part, pale-brown channery clay in the middle part, and very pale brown very channery silty clay loam in the lower part. The underlying material is very pale brown, white, and light olive-gray very channery silt loam.

Permeability is slow to a depth of about 23 inches and moderate below. The available moisture capacity is low or moderate.

Loberg soils are used mainly for woodland. They are also used for grazing and wildlife habitat.

Representative profile of Loberg very stony loam, 10 to 35 percent slopes, 1,100 feet north and 100 feet east of the SW. corner of sec. 12, T. 8 N., R. 3 E.:

O1—3 inches to 0, organic forest duff consisting of pine needles, leaves, and twigs; abrupt, smooth boundary.

A2—0 to 4 inches, light-gray (10YR 7/2) very stony loam, grayish brown (10YR 5/2) moist; strong, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine tubular pores; bleached sand and grains coating plates; clear, smooth boundary.

A&B—4 to 8 inches, grayish-brown and light brownish-gray (10YR 5/2 and 6/2) channery clay loam, dark grayish brown (10YR 4/2) moist; grayish-brown (10YR 5/2) coatings on peds; weak, sub-

angular blocky structure; slightly hard, friable, sticky and slightly plastic; many fine and very fine tubular pores; bleached sand grains coating peds; 15 to 30 percent channers; clear, wavy boundary.

B21t—8 to 13 inches, light olive-brown (10YR 5/4) channery clay loam, dark brown (10YR 4/3) rubbed and moist; moderate, medium to coarse, prismatic structure parting to strong, medium, angular blocky; very hard, firm, sticky and plastic; many fine and very fine tubular pores; thick continuous clay films on peds; bleached silt and sand grain patches decrease with increasing depth; organic stains on the vertical sides of prisms; 15 to 30 percent fine channers; clear, wavy boundary.

B22t—13 to 23 inches, pale-brown (10YR 6/3) channery clay, yellowish brown (10YR 5/4) moist; dark yellowish-brown and dark-brown (10YR 4/4 and 4/3) coatings on peds; strong, coarse, prismatic structure parting to strong, medium and coarse, angular blocky; very hard, firm, very sticky and plastic; many fine and very fine tubular pores; thick continuous clay films on peds; light organic stains on vertical sides of prisms; 35 to 50 percent coarse channers; gradual, wavy boundary.

B3—23 to 32 inches, very pale brown (10YR 7/5) very channery silty clay loam, yellowish-brown (10YR 5/6) moist; weak to moderate, medium, angular blocky structure; hard, friable, sticky and plastic; common fine tubular pores; 55 percent coarse channers; gradual, wavy boundary.

C1ca—32 to 40 inches, very pale brown (10YR 8/4) and white (10YR 8/2) very channery silt loam, yellowish brown (10YR 5/6) and light olive gray (5Y 6/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine tubular pores; 60 percent channers; strongly effervescent; gradual, wavy boundary.

C2ca—40 to 60 inches, light olive-gray (5Y 6/2) very channery silt loam, yellowish brown (10YR 5/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; 55 to 65 percent channers; strongly effervescent with common fine seams and threads of segregated lime.

The solum ranges from 30 to 60 inches in thickness.

The O1 horizon and the O2 horizon, where present, range from 2 to 10 inches thick over the mineral soil. The A2 horizon ranges from 2 to 13 inches thick over the mineral soil. It has a value of 6 or 7 when dry and 4 to 6 when moist. The A&B horizon ranges from 4 to 8 inches in thickness and has mixed colors similar to colors in the A2 and B2t horizons. The B2t horizon has a hue of 10YR or 7.5YR, a value of 4 to 6 when dry and 3 to 5 when moist, and a chroma of 2 to 4. In places there is a Cca horizon at a depth of 30 inches, or the soil is noncalcareous to a depth of 60 inches or more. It has a hue of 10YR to 5Y, a value of 7 or 8 when dry and 5 or 6 when moist, and a chroma of 5 to 6.

Coarse fragments are of gravel, cobble, and stone size and are derived from both igneous and sedimentary sources. They make up 15 to 35 percent of the upper 10 to 20 inches of the soil and 35 to 70 percent of the soil below a depth of 20 inches.

LoE—Loberg very stony loam, 10 to 35 percent slopes. This moderately steep and steep soil is on mountain foot slopes and fans.

Included with this soil in mapping are areas of Lake Creek, Rooset, and Bridger soils. Included soils make up about 20 percent of the mapping unit.

The hazard of erosion is moderate to severe. Runoff is medium to rapid.

This soil is used for woodland, wildlife habitat, and some grazing. This soil supports a dense stand of Douglas-fir and a small amount of lodgepole pine. The woodland site index is 45 to 55 for the Douglas-fir, based on Brickell curves and a 50-year base. The clayey subsoil, when saturated, causes logging operations to be delayed. Capability unit VIe-1, dryland; range site and woodland suitability group not assigned.

Lothair Series

The Lothair series consists of deep, well-drained soils on low stream terraces. These soils formed in calcareous clay alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 3,800 to 4,200 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray silty clay about 8 inches thick. The underlying material, to a depth of 60 inches, is mostly very pale brown and pink, calcareous silty clay.

Permeability is slow, and the available moisture capacity is moderate or high.

Lothair soils are used mainly for irrigated alfalfa, spring wheat, and pasture.

Representative profile of Lothair silty clay (0 to 2 percent slopes), 300 feet east of the center of sec. 10, T. 5 N., R. 2 E.:

Ap—0 to 8 inches, light brownish-gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, fine and very fine, granular structure; hard, firm, sticky and plastic; common fine pores; common worm casts; moderately effervescent; clear, smooth boundary.

C1ca—8 to 24 inches, very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; weak, thin and very thin, platy structure; hard, firm, sticky and plastic; common medium and fine pores; common worm casts, decreasing in lower part; strongly effervescent; common fine, distinct, white lime patches, specks, and threads; gradual, wavy boundary.

C2—24 to 36 inches, very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; massive; hard, firm, sticky and plastic; strongly effervescent; clear, smooth boundary.

C3—36 to 45 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and slightly plastic; strongly effervescent; clear, smooth boundary.

C4—45 to 60 inches, pink (7.5YR 7/3) silty clay, brown (7.5YR 5/4) moist; massive; hard, firm, sticky and plastic; strongly effervescent.

Between depths of 10 and 40 inches the soil ranges from 35 to 50 percent clay. In places there are some thin layers of silty clay loam.

The Ap horizon has a hue of 10YR and 2.5Y. The C horizon has a hue of 10YR or 7.5YR, a value of 6 or 7 when dry and 5 or 6 when moist, and a chroma of 2 to 4.

Lt—Lothair silty clay (0 to 2 percent slopes). This nearly level soil is on long, broad, low stream terraces. Slopes are dominantly about 1 percent.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Brocko silty clay loam in areas of Lothair soils. In some places these Brocko soils have a water table at a depth of 36 to 60 inches because of their close proximity to somewhat poorly drained soils and because of seepage from irrigation.

The hazard of erosion is slight. Runoff is medium.

This soil is used for irrigated alfalfa, spring wheat, barley, sugar beets, and pasture. Capability unit IIs-1, irrigated; Clayey range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Martinsdale Series

The Martinsdale series consists of deep, well-drained soils on broad stream terraces and fans. These soils formed in calcareous loam alluvium. Slopes range from 2 to 9 percent. Elevation ranges from 4,300 to 5,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 90 to 105 days.

In a representative profile the surface layer is dark grayish-brown loam about 8 inches thick. The subsoil, about 8 inches thick, is brown clay loam. The underlying mate-

rial is mostly white and light-gray channery loam and channery clay loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is high.

Martinsdale soils are used mostly for dryland winter wheat and range. Some small areas are irrigated.

Representative profile of Martinsdale loam, 2 to 5 percent slopes, 75 feet north of the center of sec. 11, T. 7 N., R. 3 E.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, blocky structure parting to moderate, medium, platy in lower part; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine tubular pores; abrupt, smooth boundary.

B2t—8 to 16 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; hard, firm, sticky and plastic; many fine and very fine pores; thick continuous clay films on peds; 5 percent gravel; clear, wavy boundary.

C1ca—16 to 27 inches, white (2.5Y 8/2) channery clay loam, grayish brown (2.5Y 5/2) moist; weak, medium, angular blocky structure; hard, friable, sticky and slightly plastic; common fine and very fine tubular pores; 40 percent channers; violently effervescent; undersides of channers coated with lime; common medium, distinct lime nodules; clear, wavy boundary.

C2ca—27 to 33 inches, pale-brown (10YR 6/3) channery loamy sand, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; common fine and very fine tubular pores; strongly effervescent; clear, wavy boundary.

C3ca—33 to 48 inches, white (10YR 8/2) channery clay loam, pale brown (10YR 6/3) and light gray (10YR 7/2) moist; massive; hard, friable, sticky and slightly plastic; few fine pores; violently effervescent; gradual, wavy boundary.

C4ca—48 to 60 inches, light-gray (2.5Y 7/2) channery loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine pores; violently effervescent.

The solum ranges from 10 to 18 inches in thickness. The soil ranges from 0 to 30 percent gravel- to stone-size fragments.

The A horizon has a hue of 10YR and a value of 4 or 5 when dry and 2 or 3 when moist. The B2t horizon has a hue of 10YR or 7.5YR, a value of 5 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The Cca horizon has a hue of 10YR or 2.5Y, a value of mainly 7 or 8 when dry and 5 or 6 when moist, and a chroma of 2 or 3.

MaB—Martinsdale loam, 2 to 5 percent slopes. This gently sloping soil is on broad stream terraces at elevations of 4,500 to 5,000 feet. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of a Martinsdale soil that has a slightly thinner subsoil than is typical in Martinsdale soils and small areas of Hilger loam. Included soils make up about 20 percent of the mapping unit.

The hazard of erosion is moderate. Runoff is medium.

This soil is used mostly for dryland winter wheat. Capability units IIIe-6, dryland, and IIIe-5, irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2L.

MaC—Martinsdale loam, 5 to 9 percent slopes. This sloping and rolling soil is on broad stream terraces at elevations of 4,500 to 5,000 feet. This soil has a profile similar to the one described as representative of the series, but it is steeper.

Included with this soil in mapping are small areas of a Martinsdale soil that has a thinner subsoil than is typical in Martinsdale soils and a few areas of soils that have a surface layer of silty clay loam. Also included are areas of soils that have a cobbly and gravelly surface layer. Included soils are mostly on convex areas and make up about 30 percent of the mapping unit.

The hazard of erosion is moderate. Runoff is medium.

This soil is used mostly for dryland winter wheat. Capability units IIIe-6, dryland, and IIIe-5, irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2L.

McC—Martinsdale cobbly loam, 2 to 9 percent slopes. This gently sloping and sloping soil is on fans and stream terraces. It has a profile similar to the one described as representative of the series, but the surface layer is cobbly.

Included with this soil in mapping are areas of a Martinsdale soil that has a thinner subsoil than is typical of Martinsdale soils and small areas of Perma soils. Included soils make up about 20 percent of this mapping unit.

The hazard of erosion is slight to moderate. Runoff is medium.

This soil is used for dryland winter wheat, irrigated alfalfa and grain, and some range. Capability units IIIe-6, dryland, and IIIe-5, irrigated; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 2L.

Mine Dumps

Md—Mine dumps. These are areas of waste rock that came from ore mines and from areas in which the original soil has been disturbed, overturned, or removed in placer mining. The mining has left an uneven or rough and scarred surface. Capability class VIII, dryland; range site and windbreak suitability group not assigned.

Mussel Series

The Mussel series consists of deep, well-drained soils on stream terraces and fans. These soils formed in stratified, calcareous alluvium. Slopes range from 0 to 9 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray loam about 7 inches thick. The underlying material, to a depth of 60 inches, is light-gray, light brownish-gray, and very pale brown, strongly calcareous stratified loam, silt loam, and loamy sand. The upper part of the underlying material contains more calcium carbonate than other parts in the profile.

Permeability is moderate, and the available moisture capacity is moderate or high.

Mussel soils are used for irrigated alfalfa, small grains, and sugar beets. They are also used for dryland winter wheat and range.

Representative profile of Mussel loam, 0 to 2 percent slopes, 1,300 feet west and 450 feet north of the SE. corner of sec. 3, T. 4 N., R. 1 E.:

Ap—0 to 7 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, blocky structure; hard, friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; clear, smooth boundary.

C1ca—7 to 41 inches, light-gray (10YR 7/2) loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure parting to weak, platy; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; violently effervescent; common fine filaments of lime; moderately alkaline; clear, smooth boundary.

C2—41 to 47 inches, light brownish-gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) moist; single grained; loose; 30 percent fine gravel; strongly effervescent; moderately alkaline; clear, smooth boundary.

C3—47 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The soil between depths of 10 and 40 inches contains 18 to 30 percent clay, by weighted average.

The A horizon of these soils ranges from sandy loam to silt loam and is 0 to 30 percent coarse fragments, mainly fine gravel. It has a hue of 2.5Y or 10YR, a value of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3. The Cca horizon has a hue of 2.5Y or 10YR, a value of 6 or 7 when dry and 5 or 6 when moist, and a chroma of 2 or 3. The C horizon has a hue of 10YR to 5Y, a value of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3.

MsA—Mussel loam, 0 to 2 percent slopes. This nearly level soil is on broad alluvial fans or terraces that are dissected by drainageways of intermittent streams. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas where the surface layer is silt loam, sandy loam, or silty clay loam. Also included, and making up about 20 percent of the mapped areas, are areas of Amesha silty clay loam, Havre soils, and Thess loam. The Amesha and Thess soils are within areas of Mussel soils. The Havre soils are adjacent to drainageways.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for irrigated alfalfa, wheat, sugar beets, and dryland small grains. Capability units IIIe-2, dryland, and IIc-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

MsB—Mussel loam, 2 to 5 percent slopes. This gently sloping soil is on long, smooth and broad alluvial fans or terraces that are dissected by drainageways of intermittent streams.

Included with this soil in mapping are small areas where the surface layer is sandy loam or silty clay loam. Also included, and making up about 20 percent of the mapped areas, are areas of Amesha loam, Amesha silty clay loam, and Scravo gravelly loam. The Amesha soils are located in areas where relief is flat to concave. The Scravo soil is on low ridges and along drainageways.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for irrigated alfalfa, wheat, sugar beets, and dryland small grains. Capability units IIIe-2, dryland, and IIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 2M.

Mt—Mussel-Crago complex (2 to 5 percent slopes). This complex is about 60 percent Mussel loam and 25 percent Crago gravelly loam and Crago cobbly loam. These gently sloping soils are on long alluvial fans and terraces that are dissected by drainageways of intermittent streams. The Mussel and Crago soils in this complex have profiles similar to those described as representative of their respective series, but in places the Crago soils have a surface layer of gravelly loam. The Mussel soil is in smooth areas, and the Crago soils are on low ridges and along drainageways.

Included with areas of Mussel soils in mapping are small areas of Amesha loam and Amesha sandy loam.

The hazard of soil blowing is severe. Runoff is medium.

These soils are used mainly for irrigated alfalfa, sugar beets, wheat, and dryland small grains. Capability units IIIe-2, dryland, and IIe-1, irrigated; Mussel loam in Silty range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 2M; Crago cobbly loam in Limy range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3M.

MuB—Mussel-Musselshell complex, 2 to 5 percent slopes. This complex is about 50 percent Mussel loam and 30 percent Musselshell loam and Musselshell cobbly loam. These gently sloping and gently undulating soils are on long, smooth fans that are dissected by drainageways of intermittent streams. The Mussel and Musselshell soils in this complex have profiles similar to those described as representative of their respective series, but in places the Musselshell soils do not have a cobbly surface layer. The surface layer is generally loam, but 5- to 20-acre areas of Musselshell gravelly loam and 5-acre areas of Musselshell cobbly loam are present in places.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of Amesha silt loam, Crago gravelly loam, and Crago cobbly loam. The Amesha soil is within areas of Mussel and Musselshell soils, and the Crago soils are on low ridges, terrace breaks, and steep short sides of drainageways.

The hazard of soil blowing is severe. Runoff is medium.

These soils are used mainly for range. Some areas are used for dryland and irrigated crops. Capability units IIIe-2, dryland, and IIe-1, irrigated; Mussel loam in Silty range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 2M; Musselshell loam in Limy range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3L.

MuC—Mussel-Musselshell complex, 5 to 9 percent slopes. This complex is about 40 percent Mussel loam and Musselshell cobbly loam. These sloping and rolling soils are on long, fairly smooth fans and stream terraces that are dissected by many drainageways of intermittent streams. The Mussel and Musselshell soils in this complex have profiles similar to those described as representative of their respective series, but in places the Musselshell soils do not have a cobbly surface layer.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of Amesha silt loam, Crago gravelly loam, and Crago cobbly loam. The Amesha soil is within areas of Mussel and Musselshell soils, and the Crago soils are on low ridges, terrace breaks, and short, steep sides of drainageways.

The hazard of soil blowing is severe. Runoff is medium.

These soils are used mainly for range. Some areas are used for dryland and irrigated crops. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Mussel loam in Silty range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 2M; Musselshell loam in Limy range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3L.

Musselshell Series

The Musselshell series consists of deep, well-drained soils on fans, terraces, and foot slopes. These soils formed in strongly calcareous gravelly and cobbly alluvium. Slopes range from 2 to 35 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is light brownish-gray cobbly loam about 5 inches thick. The underlying material to a depth of 43 inches is white and light-gray gravelly loam. Below this, it is light brownish-gray very gravelly loamy sand to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is low or moderate.

Musselshell soils are used for irrigated and dryland crops and range.

Representative profile of Musselshell cobbly loam in an area of Musselshell-Thess cobbly loams, 3 to 8 percent slopes, 1,200 feet south of the N. quarter corner of sec. 22, T. 7 N., R. 1 E.:

A1—0 to 5 inches, light brownish-gray (10YR 6/2) cobbly loam, dark grayish brown (10YR 4/2) moist; weak, fine, platy structure; slightly sticky, slightly hard, very friable and slightly plastic; many roots; weakly effervescent; abrupt, smooth boundary.

C1ca—5 to 26 inches, white (2.5Y 8/2) gravelly loam, light brownish gray (2.5Y 6/2) moist; massive; hard, friable, sticky and slightly plastic; common roots; 20 percent gravel; very strongly effervescent; many lime coatings on gravel; about 20 to 30 percent carbonate; clear, wavy boundary.

C2ca—26 to 43 inches, light-gray (2.5Y 7/2) gravelly loam, light olive brown (2.5Y 5/3) moist; massive; hard, friable, sticky and slightly plastic; few roots; 35 percent gravel; strongly effervescent; clear, wavy boundary.

IIC3sa—43 to 46 inches, light brownish-gray (2.5Y 6/2) very gravelly loamy sand, olive brown (2.5Y 4/3) moist; single grained; loose; 50 percent or more gravel; many pockets of gypsum; weakly effervescent; lime coatings on the bottoms of gravel; clear, wavy boundary.

IIC4—46 to 60 inches, light brownish-gray (2.5Y 6/2) very gravelly loamy sand, olive brown (2.5Y 4/3) moist; single grained; loose; 50 percent or more gravel and cobbles (igneous, argillic sandstone, and limestone rock); weakly effervescent; lime casts on the bottoms of gravel and cobbles.

Content of coarse fragments in the A horizon and between depths of 10 and 40 inches ranges from 15 to 35 percent. Below a depth of 40 inches, coarse fragments generally make up more than 50 percent of the soil. Pockets of gypsum in the lower part of the C horizon range from none to many.

The A horizon is channery loam, gravelly loam, cobbly loam, or cobbly clay loam. The A1 horizon has a hue of 10YR or 7.5YR, a value of 5 or 6 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The Cca horizon has a hue of 10YR or 2.5Y, a value of 7 or 8 when dry and 5 or 6 when moist, and a chroma of 2 or 3. The C horizon has a hue of 2.5Y or 10YR, a value of 6 to 8 when dry and 4 to 6 when moist, and a chroma of 2 or 3.

MvB—Musselshell gravelly loam, 2 to 5 percent slopes. This gently sloping soil is on long, smooth fans and stream terraces that in a few places are dissected by drainageways of intermittent streams. This soil has a profile similar to the one described as representative of the series, but the surface layer is gravelly loam.

Included with this soil in mapping, and making up about 30 percent of the mapped areas, are areas of Crago gravelly loam, Thess loam, and Thess gravelly loam. Thess soils are within areas of the Musselshell soil, and the Crago soil is commonly on low, smooth ridges adjacent to the drainageways.

The hazard of soil blowing is moderate. Runoff is medium.

This soil is used mainly for range, but some areas are used for dryland winter wheat and irrigated crops. Capability units IIIe-2, dryland, and IIe-1, irrigated; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

MvC—Musselshell gravelly loam, 5 to 9 percent slopes. This sloping soil is on fans that in a few places are dissected by drainageways of intermittent streams. Most areas are smooth and are longer than they are wide, except for some smooth, low mounds and ridges. This soil has a profile similar to the one described as representative of the series, but the surface layer is gravelly loam.

Included with this soil in mapping are areas of Crago gravelly loam and Thess gravelly loam. These included soils make up about 30 percent of the mapping unit. The Thess soil is in areas of the Musselshell soil, and the Crago soil is on low mounds and ridges and adjacent to drainageways.

The hazards of soil blowing and erosion are moderate. Runoff is medium. More than 80 percent of the acreage is gravelly or cobbly.

This soil is used mainly for range. It is also used for some irrigated and dryfarmed crops. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

MwE—Musselshell-Crago channery loams, 15 to 35 percent slopes. This complex is about 50 percent Musselshell loam and 40 percent Crago channery loam. These steep soils are on smooth, well-rounded ridges and steep terrace edges in the hilly uplands. The Musselshell and Crago soils are intermingled on the landscape, but the Crago soil is generally on the steeper side slopes and the narrower, sharp ridges. The Musselshell and Crago soils in this complex have profiles similar to those described as representative of their respective series, but the surface layer is channery loam.

Included with these soils in mapping, and making up about 10 percent of the mapped areas, are areas of Mussel and Cabbart soils and exposed soft bedrock.

The hazard of erosion is severe. Runoff is rapid.

These soils are used only for range. Some areas are timbered with scattered to fairly dense groves of ponderosa pine and juniper. Capability unit VIe-1, dryland; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

MxE—Musselshell-Crago cobbly loams, 8 to 20 percent slopes. This complex is about 55 percent Musselshell cobbly loam and 30 percent Crago cobbly loam. These sloping to steep soils are on fans, terraces, and foot slopes. Areas are mostly long and smooth, and they are bordered on either side by drainageways of intermittent streams. The Musselshell soil is on the smoother, less sloping areas; and the Crago soil is commonly on terrace breaks, foot slopes, and sides of drainageways.

Included with these soils in mapping, and making up about 15 percent of the mapped areas, are areas of Thess loam, Thess cobbly loam, Sappington loam, and Sappington cobbly loam.

The hazard of erosion is moderate. Runoff is rapid.

These soils are used mainly for range. Capability unit VIe-1, dryland; Limy range site, 10- to 14-inch precipitation zone; Musselshell soil in windbreak suitability group 3L; Crago soil in windbreak suitability group 3M.

MyC—Musselshell-Thess cobbly loams, 3 to 8 percent slopes. This complex is about 60 percent Musselshell cobbly loam and 30 percent Thess cobbly loam. These gently sloping and sloping soils are on fans and terraces that are

dissected by channels of intermittent streams. The landscape is undulating across the slope. The Musselshell and Thess soils are intermingled. The Musselshell soil in this complex has the profile described as representative of the Musselshell series. The Thess soil in this complex has a profile similar to the one described as representative of the Thess series, but the surface layer is cobbly.

Included with these soils in mapping, and making up about 10 percent of the mapped areas, are areas of Crago cobbly loam that occur mainly on undulating mounds and ridges adjacent to drainageways.

The hazard of soil blowing is moderate. Runoff is medium. The soils in this complex are 20 to 35 percent coarse fragments in the upper 20 inches.

These soils are used mainly for range. Some small areas are used for irrigated and dryland crops. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

Nielsen Series

The Nielsen series consists of shallow, well-drained soils on side slopes and ridges of hilly and mountainous uplands. These soils formed in loamy material weathered from shale rock or argillite. Slopes range from 15 to 60 percent. Elevation ranges from 5,000 to 6,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is less than 90 days.

In a representative profile the surface layer is dark-gray channery loam about 5 inches thick. The subsoil is about 9 inches thick. The upper part is dark grayish-brown channery silty clay loam, and the lower part is pale-brown very channery silty clay loam. Strongly calcareous, fractured argillite bedrock is at a depth of 14 inches.

Permeability is moderate, and the available moisture capacity is very low.

Nielsen soils are used for range.

Representative profile of Nielsen channery loam, 15 to 60 percent slopes, 1,985 feet west and 665 south of the center of sec. 3, T. 8 N., R. 3 E.:

A1—0 to 5 inches, dark-gray (10YR 4/1) channery loam, very dark brown (10YR 2/2) moist; weak, blocky structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; clear, smooth boundary.

B21t—5 to 9 inches, dark grayish-brown (10YR 4/2 crushed) channery silty clay loam with grayish-brown (10YR 5/2) coatings on peds, dark brown (10YR 3/3 crushed) with very dark grayish-brown (10YR 3/2) coatings on peds moist; moderate, medium, blocky structure; hard, friable, sticky and slightly plastic; many fine pores; moderately thick continuous clay films on vertical surfaces of peds and patchy clay films on horizontal surfaces of peds; 30 percent channers; clear, smooth boundary.

B22t—9 to 14 inches, pale-brown (10YR 6/3) very channery silty clay loam, brown (10YR 4/3) moist; moderate, fine, blocky structure; hard, friable, sticky and slightly plastic; many fine pores; moderately thick continuous clay films on vertical surfaces of peds and patchy clay films on horizontal surfaces of peds; 60 percent channers; abrupt, wavy boundary.

R—14 inches, white (10YR 8/2) lime-coated, fractured bedrock that has silty clay loam between fractures, pale brown (10YR 6/3) moist; violently effervescent.

The solum ranges from 10 to 16 inches in thickness. Depth to bedrock ranges from 10 to 20 inches. The soil ranges from 35 to 60 percent coarse fragments, mainly angular gravel.

The A1 horizon has a value of 3 or 4 when dry and 2 or 3 when moist and a chroma of 1 or 2. The B2t horizon has a value of 4 to 6 when dry and 3 or 4 when moist and a chroma of 2 or 3.

NeF—Nielsen channery loam, 15 to 60 percent slopes. This steep and very steep soil is on side slopes and ridges in the mountainous uplands.

Included with this soil in mapping, and making up about 25 percent of the mapped areas, are areas of Cheadle loam, Cheadle channery loam, Passcreek channery loam, and Nielsen very channery loam. The Cheadle soils are on ridgetops and breaks below the ridgetops. The Passcreek soil is on the less sloping parts of the areas, and the Nielsen soil is on ridgetops and steep side slopes. Also included, in the upper part of the Ray Creek and Dry Creek drainageways, are areas of a soil that is similar to this Nielsen soil but that is noncalcareous.

The hazard of erosion is severe. Runoff is rapid.

This soil is used for range. Capability unit VIe-1, dryland; Shallow range site, 15- to 19-inch precipitation zone; windbreak suitability group 4.

Passcreek Series

The Passcreek series consists of moderately deep, well-drained soils on benches, ridges, and side slopes in mountainous uplands. These soils formed in loamy material weathered from shale rock and argillite. Slopes range from 6 to 35 percent. Elevation ranges from 5,000 to 7,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is less than 90 days.

In a representative profile the surface layer is grayish-brown channery silt loam about 7 inches thick. The subsoil, about 7 inches thick, is grayish-brown and pale-brown silty clay loam. The underlying material is white and pale-yellow channery and very channery silt loam and very channery clay loam. Argillite bedrock is at a depth of 38 inches.

Permeability is moderate, and the available moisture capacity is low or very low.

Passcreek soils are used mainly for dryland winter wheat and range.

Representative profile of Passcreek channery silt loam, 6 to 15 percent slopes, 1,000 feet north and 400 feet west of the SE. corner of sec. 1, T. 7 N., R. 3 E.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) channery silt loam, very dark gray (10YR 3/1) moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; many fine pores; about 20 percent fine angular gravel; abrupt, smooth boundary.

B2t—7 to 11 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; hard, friable, sticky and plastic; many fine pores; about 15 percent fine angular gravel; clear, smooth boundary.

B3ca—11 to 14 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; hard, friable, sticky and slightly plastic; many fine pores; about 15 percent angular gravel fragments; weakly effervescent to strongly effervescent; clear, smooth boundary.

C1ca—14 to 21 inches, white (10YR 8/2) channery silt loam, light brownish gray (10YR 6/2) moist; moderate, medium, angular blocky structure; hard, very friable, sticky and slightly plastic; 20 percent angular gravel; violently effervescent; gravel coated with lime, common medium, distinct lime splotches; clear, wavy boundary.

C2ca—21 to 26 inches, white (2.5Y 8/3) channery silt loam, light olive gray (5Y 6/2) moist; weak, medium and coarse, angular blocky structure; hard, very friable, sticky and slightly plastic; many fine pores; 40 to 50 percent angular gravel; violently efferves-

cent; few fine, distinct lime splotches, gravel coated with lime; gradual, wavy boundary.

C3ca—26 to 38 inches, pale-yellow (2.5Y 8/4) very channery clay loam, pale olive (5Y 6/4) moist; massive; hard, friable, sticky and plastic; 70 to 90 percent angular gravel; strongly effervescent; undersides of gravel coated with lime; gradual, wavy boundary.

R—38 inches, gray, fractured, noncalcareous argillite that has clay loam in fractures.

The solum ranges from 10 to 20 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. The soil ranges from 15 to 50 percent or more angular gravel. The highest amount of angular gravel is in the lower part of the Cca horizon. The B3Ca horizon is absent from some places. Some cultivated soils develop a platy plow sole near the bottom of the Ap horizon.

The A horizon has a hue of 10YR or 2.5Y, a value of 4 or 5 when dry and 2 or 3 when moist, and a chroma of 1 or 2. The B2t horizon has a hue of 10YR or 2.5Y, a value of 5 or 6 when dry and 3 or 4 when moist, and a chroma of 2 or 3. The Cca horizon has a hue of 10YR or 2.5Y, a value of 7 or 8 when dry and 5 or 6 when moist, and a chroma of 2 or 3.

PaD—Passcreek channery silt loam, 6 to 15 percent slopes. This sloping, rolling and hilly soil is on benches, ridges, and side slopes in the mountainous uplands. Slopes are dominantly 8 to 10 percent, but they range from 6 to 15 percent. Elevations range from 5,200 to 5,700 feet. This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas of Nielsen channery loam, Nielsen very channery loam, a silty soil that is more than 40 inches deep over bedrock, and a very channery soil that is less than 10 inches deep over bedrock. Included soils make up about 25 percent of the mapped areas. The Nielsen soils are on ridges and side slopes. Also included in mapping are a few areas of soils that have a stony surface layer.

The hazard of erosion is moderate to severe. Runoff is medium to rapid.

This soil is used mainly for dryland winter wheat and range. Capability unit IVe-2, dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

PcE—Passcreek-Lake Creek channery loams, 15 to 35 percent slopes. This complex is about 40 percent Passcreek channery loam and 40 percent Lake Creek channery loam. These steep soils are on benches and side slopes that are mostly 1,000 to 2,000 feet long. The Passcreek soil in this complex has a profile similar to the one described as representative of the Passcreek series, but the Passcreek soil has a surface layer of channery loam. The Passcreek soil is mostly in long, narrow stringers or blocklike areas that are separated by areas of the Lake Creek soil.

Included with these soils in mapping, and making up about 20 percent of the mapped areas, are areas of Nielsen channery loam, generally on the upper part of slopes near the ridges.

The hazard of erosion is moderate to severe. Runoff is medium to rapid.

These soils are used mainly for range. Some areas of the Lake Creek soil are used for woodland. Capability unit VIe-1, dryland; Passcreek soil in Silty range site, 15- to 19-inch precipitation zone, and in windbreak suitability group 4; Lake Creek soil not assigned to a range site or windbreak suitability group.

Perma Series

The Perma series consists of deep, well-drained soils on fans and terraces. These soils formed in noncalcareous very gravelly and cobbly loamy and sandy alluvium. Slopes range from 2 to 5 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 90 to 105 days.

In a representative profile the surface layer is grayish-brown very cobbly loam about 3 inches thick. The subsoil, about 11 inches thick, is dark grayish-brown and dark-brown very cobbly heavy loam and very cobbly heavy sandy loam. The underlying material is pale-brown very gravelly loam and very gravelly sandy loam to a depth of about 43 inches. Below this, to a depth of 60 inches, it is loose sand and gravel.

Permeability is moderate to a depth of about 26 inches and moderately rapid and rapid below. The available moisture capacity is low.

Perma soils are used for range.

Representative profile of Perma very cobbly loam (2 to 5 percent slopes), 950 feet south and 550 feet west of the NE. corner of sec. 36, T. 9 N., R. 1 W.:

A1—0 to 3 inches, grayish-brown (10YR 5/2) very cobbly loam, dark brown (10YR 3/3) moist; moderate, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; clear, smooth boundary.

B2—3 to 8 inches, dark grayish-brown (10YR 4/2) very cobbly heavy loam, dark brown (10YR 3/3) moist; moderate, medium, blocky structure; hard, friable, sticky and slightly plastic; gradual, smooth boundary.

B3—8 to 14 inches, dark-brown (10YR 4/3) very gravelly heavy sandy loam, dark brown (10YR 3/3) moist; weak, medium, blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; gradual, smooth boundary.

C1—14 to 26 inches, pale-brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; weak, medium, blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; gradual, wavy boundary.

C2—26 to 43 inches, pale-brown (10YR 6/3) very gravelly sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and nonplastic; gradual, wavy boundary.

C3—43 to 60 inches, loose sand and gravel.

Cobbles and gravel make up about 50 to 55 percent, by volume, of the upper 9 inches and increase with depth to about 70 percent below a depth of 24 inches. Loose sand and gravel is at a depth of 40 to 60 inches.

The soil has a hue of 10YR or 7.5YR. The A and B horizons have a value of 4 or 5 when dry and 2 or 3 when moist and a chroma of 2 or 3. The C horizon has a value of 5 or 6 when dry and 4 or 5 when moist and a chroma of 2 or 3.

Pm—Perma very cobbly loam (2 to 5 percent slopes). This gently sloping and gently undulating soil is on fans and terraces that are dissected by shallow drainageways of intermittent streams. Most areas are long and narrow. This soil has the profile described as representative of the series.

Included with this soil in mapping, and making up about 25 percent of the mapped areas, are areas of Hilger very cobbly loam that have a profile similar to the one described as representative of the Hilger series but that contain less lime. Included areas of Martinsdale gravelly loam and Martinsdale cobbly loam make up about 15 percent of the mapping unit. They are 2 to 10 acres in size within areas of Perma soils.

The hazard of erosion is slight. Runoff is slow. More than 60 percent of the surface of this mapping unit is very cobbly.

This soil is used for range. Capability unit VIs-1, dryland; Stony range site, 15- to 19-inch precipitation zone; windbreak suitability group 3M.

Pr—Perma very cobbly loam, wet (2 to 5 percent slopes). This gently sloping soil is on stream terraces that are dissected by many meandering, shallow drainageways. This soil has a profile similar to the one described as representative of the series, but a water table is at a depth of 36 to 60 inches.

Included with this soil in mapping, and making up about 30 percent of the mapped areas, are areas of Hilger very cobbly loam, Martinsdale cobbly loam, and some stony soils along shallow drainageways.

The hazard of erosion is slight. Runoff is slow.

This soil is used for range. Capability unit VIw-1, dryland; Subirrigated range site, 10- to 14-inch precipitation zone; windbreak suitability group 2W.

Radersburg Series

The Radersburg series consists of deep, well-drained soils on fans and terraces. These soils formed in gravelly and cobbly old alluvium. Slopes range from 2 to 5 percent. Elevation ranges from 3,800 to 4,700 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is grayish-brown very cobbly loam about 4 inches thick. The subsoil, about 10 inches thick, is brown cobbly clay. The underlying material to a depth of 30 inches is light-gray, strongly calcareous cobbly silt loam. Below this, to depth of 60 inches, it is light yellowish-brown, moderately calcareous very cobbly loam.

Permeability is moderate, and the available moisture capacity is low.

Radersburg soils are used for range.

Representative profile of Radersburg very cobbly loam (2 to 5 percent slopes), 300 feet west of the center of sec. 28, T. 8 N., R. 1 E.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate, thin, platy structure parting to moderate, very fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; about 55 percent cobbles and gravel; many fine and very fine roots; many fine and very fine pores; mildly alkaline; abrupt, smooth boundary.

B2t—4 to 14 inches, brown (10YR 5/3) cobbly clay, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, fine, angular blocky; hard, firm, sticky and plastic; many fine and very fine roots; many fine and very fine pores; moderately thick clay films on peds; about 40 percent cobbles and gravel; mildly alkaline; clear, smooth boundary.

C1ca—14 to 30 inches, light-gray (10YR 7/2) cobbly silt loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and slightly plastic; about 45 percent cobbles and gravel; strongly effervescent; calcium carbonate coatings on undersides of cobbles and gravel; clear, wavy boundary.

C2—30 to 60 inches, light yellowish-brown (2.5Y 6/4) very cobbly loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; about 55 percent cobbles and gravel; moderately effervescent.

The solum ranges from 10 to 14 inches in thickness. The soil has a hue of 10YR or 2.5Y throughout.

The A horizon is very cobbly loam and stony loam. It has a value of 4 or 5 when dry and 2 or 3 when moist and a chroma of 2 or 3. The B2t horizon has a value of 4 or 5 when dry and 3 or 4 when moist. The Cca horizon has a value of 6 or 7 when dry and 4 or 5 when moist and a chroma of 2 or 3. Gravel and cobbles in the B2t and Cca horizons range from 35 to 50 percent. The underlying C horizon is 40 to 55 percent cobbles and gravel.

Ra—Radersburg very cobbly loam (2 to 5 percent slopes). This gently sloping soil is on fans and terraces that in many places are dissected by shallow drainageways. Areas are long and broad and are commonly several hundred acres in size.

Included with this soil in mapping are areas of Musselshell, Thess, and Sappington soils. These included soils are in 1- to 5-acre areas and make up about 30 percent of the mapping unit. Also included are areas that have very cobbly loamy sand at depths of 40 to 60 inches. In the area of the Crow Creek drainageway, some of the Radersburg soils have a stony surface.

The hazard of erosion is slight. Runoff is medium.

This soil is used for range. Capability unit VIs-1, dryland; Stony range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Rencot Series

The Rencot series consists of shallow, well-drained soils on uplands. These soils formed in calcareous channery and very channery loam residuum weathered from hard argillite or sandstone. Slopes range from 15 to 35 percent. Elevation ranges from 3,800 to 5,000 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is pale-brown channery loam about 4 inches thick. The underlying material is strongly calcareous, white and pale-yellow channery loam and very channery loam. Argillite bedrock is at a depth of 18 inches.

Permeability is moderate, and the available moisture capacity is very low.

Rencot soils are used for range.

Representative profile of Rencot channery loam, 15 to 35 percent slopes, 1,900 feet east and 1,700 feet north of the SW. corner of sec. 18, T. 8 N., R. 3 E.:

A1—0 to 4 inches, pale-brown (10YR 6/3) channery loam, brown (10YR 5/3) moist; moderate, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; about 15 percent angular gravel; strongly effervescent; clear, smooth boundary.

C1ca—4 to 14 inches, white (2.5Y 8/2) channery loam, light brownish gray (2.5Y 6/2) moist; weak, coarse, blocky structure; hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; about 40 percent angular gravel; violently effervescent; common soft masses of calcium carbonate, lime coatings on undersides of gravel; clear, smooth boundary.

C2ca—14 to 18 inches, pale-yellow (2.5Y 7/4) very channery loam, light olive brown (2.5Y 5/4) moist; massive, slightly hard, very friable, slightly sticky and slightly plastic; about 60 percent coarse fragments; violently effervescent; abrupt, wavy boundary.

R—18 to 40 inches, fractured, hard argillite bedrock.

Depth of bedrock ranges from 10 to 20 inches. The soil has a hue of 10YR or 2.5Y throughout.

The A horizon has a value of 5 or 6 when dry and 3 to 5 when moist and a chroma of 2 or 3. The Cca horizon has a value of 6 to 8 when dry and 5 to 7 when moist and a chroma of 2 to 4. It ranges from 15 to 30 percent soft masses of calcium carbonate and lime casts on fragments. Channers in the C horizon range from 35 to 65 percent.

ReE—Rencot channery loam, 15 to 35 percent slopes. This steep soil is on mountainous uplands that have smooth, rounded to sharp ridges. Slopes are dominantly 15 to 35 percent, but in places they range from 10 to 50 per-

cent. Areas are several hundred acres in size and are underlain by tilted, parallel beds of argillite, quartzite, metamorphosed sandstone, and calcareous shale rock.

Included with this soil in mapping are areas of Tolman channery loam, Tolman stony loam, Rootel channery loam, Rootel stony loam, and some Rock outcrop. Included soils make up about 40 percent of this mapping unit. The Tolman soils are within areas of the Rencot soil. The Rootel soils are on foot slopes and fans and in swales. Rock outcrop is dominantly along ridgetops, but it occurs throughout the landscape.

The hazard of erosion is severe. Runoff is rapid.

This soil is used for range. Capability unit VIe-1, dryland; Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Rivra Series

The Rivra series consists of deep, moderately well drained soils on low stream terraces that are subject to overflow. These soils formed in recently deposited gravelly and cobbly sandy alluvium. Slopes range from 0 to 5 percent. Elevation ranges from 3,700 to 4,100 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

In a representative profile the surface layer is light brownish-gray and grayish-brown gravelly loam about 4 inches thick. The underlying material is mostly light brownish-gray very gravelly sand to a depth of 60 inches or more.

Permeability is rapid, and the available moisture capacity is very low. A seasonal high water table is at a depth of 36 to more than 72 inches.

Rivra soils are used for range.

Representative profile of Rivra gravelly loam (0 to 5 percent slopes), at the NW. corner of sec. 21, T. 5 N., R E.:

A1—0 to 4 inches, light brownish-gray and grayish-brown (10YR 6/2 and 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; clear, smooth boundary.

C1—4 to 21 inches, light brownish-gray (2.5Y 6/2) very gravelly sand, dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) moist; loose; common roots; about 55 percent gravel; clear, wavy boundary.

C2—21 to 24 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few roots; weakly effervescent; clear, wavy boundary.

C3—24 to 60 inches, light brownish-gray (2.5Y 6/2) very gravelly sand, dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) moist; loose; 70 percent gravel.

Hue is 10YR or 2.5Y throughout.

The A horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 1 or 2. The C horizon has a value of 5 or 6 when dry and 4 or 5 when moist and a chroma of 1 or 2. It ranges from 50 to 70 percent gravel and cobbles.

Rr—Rivra gravelly loam (0 to 5 percent slopes). This nearly level to gently sloping and gently undulating soil is mostly along the Missouri River on low stream terraces. The surface is broken by low ridges and shallow drainageways. This soil is subject to overflow. A seasonal high water table is at a depth of 36 to more than 72 inches.

Included with this soil in mapping are some areas of gravelly sandy loam, very gravelly sandy loam, very gravelly loam, and Villy soils and some other poorly drained soils in shallow, concave areas. Included soils make up about 30 percent of the mapping unit. The very gravelly soils commonly are on low ridges.

The hazard of erosion is slight. Runoff is very slow.

This soil is used for range. Capability unit VIs-1, dryland; Overflow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Rock Outcrop

Rock outcrop is a miscellaneous land type that occurs throughout the survey area in the sedimentary uplands. It is mainly on ridgetops, along canyon rims, and on steep mountain slopes. It consists mostly of bare bedrock, but in some places less than 10 inches of soil material is over the bedrock.

Areas of Rock outcrop in the Broadwater County Area are too small to be mapped separately. They are mapped with Tropal and Woodrock soils.

Rock outcrop is used for wildlife habitat and recreation.

Rooset Series

The Rooset series consists of deep, well-drained soils on fans and terraces near the mountains. These soils formed in weakly calcareous or moderately calcareous very stony clay loam alluvium. Slopes range from 9 to 35 percent. Elevation is about 5,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free season is 60 to 90 days.

In a representative profile the surface layer is dark grayish-brown extremely stony loam about 3 inches thick. The subsoil is about 21 inches thick. It is dark grayish-brown stony clay loam in the upper part, brown very cobbly loam in the lower part. The underlying material to a depth of 36 inches is pale-brown, noncalcareous very stony clay loam. Below this, it is very pale brown, strongly calcareous very stony clay loam.

Permeability is moderate, and the available moisture capacity is low.

Rooset soils are used for range.

Representative profile of Rooset extremely stony loam, 9 to 35 percent slopes, 600 feet west and 1,300 feet south of the N. quarter corner of sec. 30, T. 9 N., R. 3 E.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) extremely stony loam, very dark gray (10YR 3/1) moist; moderate, thin, platy structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; clear, smooth boundary.

B1—3 to 8 inches, dark grayish-brown (10YR 4/3 crushed) stony clay loam with dark-gray (10YR 4/1) coatings on peds, very dark brown (10YR 2/2 crushed) with very dark brown (10YR 2/2) coatings on peds moist; moderate, medium, platy structure; slightly hard, friable, slightly plastic and sticky; many fine pores; clear, smooth boundary.

B2t—8 to 16 inches, brown (10YR 5/3 crushed) very cobbly light clay with brown (10YR 5/2) coatings on peds, dark brown (10YR 3/3 crushed) with dark-brown (10YR 3/2) coatings on peds moist; strong, medium, prismatic structure parting to strong, medium, blocky; hard, firm sticky and plastic; many fine pores; thick continuous clay films on peds, organic stains on vertical sides of prisms; many krotovinas; clear, smooth boundary.

B3—16 to 24 inches, pale-brown (10YR 6/3 crushed) very stony clay loam with pale-brown (10YR 6/3) coatings on peds, brown (10YR 4/3 crushed) with brown (10YR 4/3) coatings on peds moist; moderate, medium, blocky structure; hard, friable, sticky and slightly plastic; many fine pores; patchy clay films on peds; gradual, wavy boundary.

C1—24 to 36 inches, pale-brown (10YR 6/3) very stony clay loam, yellowish brown (10YR 5/4) moist; weak, coarse, blocky structure; slightly hard, friable, sticky and slightly plastic; abrupt, wavy boundary.

C2ca—36 to 60 inches, very pale brown (10YR 7/3) very stony clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky and plastic; strongly effervescent; lime coatings on the undersides of stones.

The solum ranges from 15 to 50 inches in thickness. Volume of stones generally increases with increasing depth from about 35 to 60 percent in the A and B horizons to 50 to 70 percent in the C horizon. The soil has a hue of 2.5Y to 7.5YR throughout.

The A horizon has a value of 3 or 4 when dry and 2 or 3 when moist and a chroma of 1 or 2. The B2t horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 3 to 6. The Cca horizon has a value of 6 or 7 when dry and 4 or 5 when moist and a chroma of 3 to 5.

RsE—Rooset extremely stony loam, 9 to 35 percent slopes. This moderately steep and steep soil is on fans and foot slopes at elevations of more than 5,000 feet. Most areas are several hundred acres in size. Stones cover 35 to 60 percent of the surface, but dominantly 40 to 50 percent.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are 10- to 30-acre areas of Bridger soils.

The hazard of erosion is moderate. Runoff is medium.

This soil is used only for range. Capability unit VIs-1, dryland; Stony range site, 15- to 19-inch precipitation zone; windbreak suitability group 4.

Rootel Series

The Rootel series consists of moderately deep, well-drained soils on side slopes, short fans, and foot slopes in the uplands. These soils formed in strongly calcareous channery loam material weathered mostly from calcareous argillite rock. Slopes range from 3 to 9 percent. Elevation ranges from 3,500 to 5,000 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

In a representative profile the surface layer is grayish-brown channery loam about 3 inches thick. The underlying material is light brownish-gray and white, strongly calcareous channery loam. Argillite bedrock is at a depth of 23 inches.

Permeability is moderate, and the available moisture capacity is low.

Rootel soils are used mostly for range. A few areas are used for dryland crops.

Representative profile of Rootel channery loam, 3 to 9 percent slopes, 500 feet southwest of the N. quarter corner of sec. 34, T. 3 N., R. 1 E.:

A1—0 to 3 inches, grayish-brown (10YR 5/2) channery loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; 10 percent channers; slightly effervescent; clear, wavy boundary.

C1—3 to 7 inches, light brownish-gray (10YR 6/2) channery loam, grayish brown (10YR 5/2) moist; weak, fine, blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few fine roots; few fine pores; 10 percent channers; strongly effervescent; lime coatings on undersides of channers; clear, wavy boundary.

C2ca—7 to 23 inches, white (10YR 8/2) channery loam, pale brown (10YR 6/3) moist; weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; 15 percent channers; violently effervescent; lime coatings on undersides of channers; abrupt, wavy boundary.

R—23 inches, fractured, hard, calcareous argillite bedrock.

Volume of channers ranges from 15 to 30 percent throughout the soil. The soil has a hue of 10YR or 2.5Y throughout.

The A horizon has a value of 5 or 6 when dry and 4 or 5 when moist and a chroma of 2 or 3. The C horizon has a value of 6 to 8 when dry and 4 to 6 when moist and a chroma of 2 or 3. It ranges from 18 to 30 percent clay. Segregated lime in the Cca horizon occurs in the form of threads and splotches and as lime coatings on undersides of channers.

RtC—Rootel channery loam, 3 to 9 percent slopes. This gently sloping and sloping soil is on side slopes, short fans, and foot slopes in the uplands.

Included in this soil in mapping, and making up about 30 percent of the mapped areas, are areas of Rencot, Amesha, and Mussellshell soils. The Rencot soil is along ridges, and the Amesha and Musselshell soils are in concave areas and on the larger fans.

The hazard of soil blowing is severe. Runoff is medium or rapid.

The soil is used mostly for range. Some small areas are used for dryland crops. Capability unit IIIe-4, dryland; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Sappington Series

The Sappington series consists of deep, well-drained soils on benches and old stream terraces. These soils formed in calcareous loamy alluvium. Slopes range from 2 to 9 percent. Elevation ranges from 4,000 to 4,800 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown clay loam about 6 inches thick. The subsoil, about 3 inches thick, is brown gravelly clay loam. The underlying material is white and light-gray loam and gravelly loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is moderate or high.

Sappington soils are used for irrigated and dryland crops and range.

Representative profile of Sappington clay loam, 2 to 5 percent slopes, 700 feet west and 200 feet north of the center of sec. 5, T. 9 N., R. 1 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium blocky structure; soft, very friable, sticky and slightly plastic; 5 percent gravel; clear, smooth boundary.

B2t—6 to 9 inches, brown (10YR 5/3) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common fine pores; 15 percent gravel; clear, smooth boundary.

C1ca—9 to 36 inches, white (10YR 8/2) loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; 5 percent gravel; strongly effervescent; common medium and large lime splotches and nodules and thick lime coatings on gravel; gradual, wavy boundary.

C2ca—36 to 60 inches, light-gray (2.5Y 7/2) gravelly loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; 15 to 30 percent gravel; strongly effervescent.

The solum ranges from 7 to 10 inches in thickness. Volume of gravel between depths of 10 to 40 inches ranges from 10 to 30 percent. The soil has a hue of 10YR or 2.5Y throughout.

The A horizon is loam or gravelly clay loam. The A and B2t horizons have a value of 5 when dry and 3 or 4 when moist and a chroma of 2 or 3. The Cca horizon has a value of 6 to 8 when dry and 5 to 7 when moist and a chroma of 2 or 3. It is 15 to 35 percent calcium carbonate.

SaB—Sappington clay loam, 2 to 5 percent slopes. This gently sloping and gently undulating soil is on benches and high, old stream terraces that are dissected by drainageways. Areas are smooth and large. This soil has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Musselshell soils. Also included are areas of Crago soils that make up about 5 percent of the acreage. The Crago and Musselshell soils generally are on low ridges and knobs. They are also on steep, sharp sides of drainageways. Also included are some areas of Sappington silt loam on high benches southeast of Townsend.

The hazard of erosion is slight. Runoff is medium.

These soils are used mainly for winter wheat. Some areas are used for irrigated crops and range. Capability units IIIe-2, dryland, and IIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

SaC—Sappington clay loam, 5 to 9 percent slopes. This sloping soil is on large, broad, smooth areas on benches and high stream terraces that are dissected by drainageways.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Musselshell loam and Musselshell gravelly loam. Also included are areas of Crago gravelly loam and Crago cobbly loam that make up about 5 percent of the acreage. The Musselshell and Crago soils are on low mounds, ridges, and short sides of drainageways. Also included are a few areas of a Sappington soil that has a gravelly surface layer and a few areas of Sappington silt loam on the high benches southeast of Townsend.

The hazard of erosion is moderate. Runoff is medium.

This soil is used mainly for dryland winter wheat and range. Some areas are used for irrigated crops. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

SgB—Sappington gravelly clay loam, 2 to 5 percent slopes. This gently sloping and gently undulating soil is on benches and high stream terraces that are dissected by drainageways. This soil has a profile similar to the one described as representative of the series, but the surface layer is gravelly clay loam.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Musselshell gravelly loam and Crago gravelly loam on low ridges, knobs, and steep, sharp slopes. Also included are 1- to 5-acre areas of nongravelly Sappington soils throughout the unit.

The hazard of erosion is slight. Runoff is medium.

This soil is used mainly for dryland winter wheat. Some areas are used for irrigated crops and range. Capability units IIIe-2, dryland, and IIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

SgC—Sappington gravelly clay loam, 5 to 9 percent slopes. This sloping soil is on broad, smooth slopes on benches and high stream terraces that are dissected by drainageways. This soil has a profile similar to the one described as representative of the series, but the surface layer is gravelly.

Included with this soil in mapping, and making up about 20 percent of the mapped areas, are areas of Musselshell gravelly loam and Musselshell cobbly loam. Also included are areas of Crago gravelly loam and Crago cobbly loam that make up about 10 percent. The Musselshell and Crago soils are on ridges, knobs, and steep, short sides of drainageways. Also included are small areas of nongravelly Sappington soils.

The hazard of erosion is moderate. Runoff is medium.

This soil is used for dryland and irrigated crops and range. Capability units IIIe-4, dryland, and IIIe-1, irrigated; Silty range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

Scravo Series

The Scravo series consists of deep, somewhat excessively drained soils on fans and stream terraces. These soils formed in calcareous gravelly loam alluvium. Slopes range from 0 to 5 percent. Elevation ranges from 3,800 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is grayish-brown cobbly loam about 6 inches thick. The underlying material to a depth of 17 inches is light brownish-gray and light-gray, strongly calcareous cobbly loam and very gravelly sandy loam. Below this, it is light-gray very gravelly loamy sand to a depth of 60 inches or more.

Permeability is moderately rapid to a depth of about 17 inches and rapid below. The available moisture capacity is very low or low.

Scravo soils are used mainly for range. Some areas are used for irrigated hay and pasture.

Representative profile of Scravo cobbly loam (0 to 2 percent slopes), 950 northwest of the S. quarter corner of sec. 27, T. 8 N., R. 2 E.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) cobbly loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; slightly effervescent; moderately alkaline; clear, smooth boundary.

C1ca—6 to 9 inches, light brownish-gray (10YR 6/2) cobbly loam, brown (10YR 5/3) moist; weak, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common roots; many very fine pores; strongly effervescent; moderately thick lime coatings on the undersides of cobbles; moderately alkaline; clear, smooth boundary.

C2ca—9 to 17 inches, light-gray (10YR 7/2) gravelly sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky; common roots; 50 percent gravel and cobbles; violently effervescent; common white lime accumulations, thick white coatings on the undersides of pebbles and cobbles; moderately alkaline; clear, wavy boundary.

IICa—17 to 60 inches, light-gray (2.5Y 7/2) very gravelly loamy sand, grayish brown (2.5Y 5/2) moist; single grained; loose, nonsticky and nonplastic; few roots in upper part; 60 percent gravel and cobbles; strongly effervescent; thin lime coatings on the undersides of pebbles and cobbles.

Depth to very gravelly loamy sand ranges from 10 to 20 inches, but it is generally about 17 inches. The soil has a hue of 10YR or 2.5Y. The A horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 2 or 3. The Cca horizon has a value of 7 or 8 when dry and 5 to 7 when moist and a chroma of 2 or 3. It ranges from 15 to 35 percent calcium carbonate. The C horizon ranges from 30 to 60 percent gravel and cobbles.

Sv—Scravo cobbly loam (0 to 2 percent slopes). This nearly level soil is on stream terraces. It has the profile described as representative of the series.

Included with this soil in mapping are areas of Thess loam and Thess gravelly loam that make up about 20 percent of the mapped areas and areas of Crago gravelly loam and Crago very gravelly loam that make up about 15 percent. The Thess soils are mostly in slightly concave areas, and the Crago soils are on low, narrow ridges.

The hazard of erosion is slight. Runoff is medium or slow.

The soil is used mostly for range. It is also used for irrigated alfalfa and pasture. Capability units VIs-1, dryland, and IVs-1, irrigated; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Sw—Scravo very cobbly loam (0 to 5 percent slopes). This nearly level and gently undulating soil is on stream terraces and alluvial fans. Low, smooth ridges and shallow, concave areas occur throughout the mapped areas. This soil has a profile similar to the one described as representative of the series, but the surface layer is very cobbly and in places there is weak lime cementation in the upper part of the underlying material.

Included with this soil in mapping, and making up about 25 percent of the mapped areas, are areas of Thess loam and Thess gravelly loam along narrow, concave areas.

The hazard of erosion is slight. Runoff is medium. More surface cobbles are along the ridges than in other places.

This soil is used for range. Capability unit VIs-1, dryland; Shallow to Gravel range site, 10- to 14-inch precipitation zone; windbreak suitability group 3M.

Thess Series

The Thess series consists of deep, well-drained soils on stream terraces and fans. These soils formed in strongly calcareous gravelly and cobbly alluvium of mixed origin. Slopes range from 0 to 3 percent. Elevation ranges from 3,500 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is pinkish-gray loam about 5 inches thick. The underlying material to a depth of 34 inches is light-gray and very pale brown, very strongly calcareous loam and silt loam. Below this, it is very gravelly sand to a depth of 60 inches or more.

Permeability is moderate to a depth of about 34 inches and rapid below. The available moisture capacity is low or moderate.

Thess soils are used for irrigated hay and grain and dryland grain and range.

Representative profile of Thess loam in an area of Thess-Scravo complex (0 to 2 percent slopes), 100 feet north and 50 feet east of the SW. corner of sec. 7, T. 5 N., R. 2 E.:

A1—0 to 5 inches, pinkish-gray (7.5YR 6/2) loam, brown (7.5YR 4/2) moist; strong, thin, platy structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; moderately effervescent; moderately alkaline; clear, smooth boundary.

C1ca—5 to 22 inches, light-gray (10YR 7/2) loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; 10 percent gravel and cobbles; strongly effervescent; lime coatings on pebbles and cobbles; strongly alkaline; clear, smooth boundary.

C2—22 to 34 inches, very pale brown (10YR 7/3) stratified silt loam and loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few roots; 10 percent gravel and cobbles; strongly effervescent; moderately alkaline; abrupt, wavy boundary.

IIC3—34 to 60 inches, very gravelly sand; single grained; loose; 70 percent gravel and cobbles; weakly effervescent; thin lime coatings on undersides of pebbles and cobbles.

Depth to the IIC horizon ranges from 20 to 35 inches. The soil below the A horizon has a hue of 10YR or 2.5Y.

The A horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 2 or 3. Averaged, the upper 7 inches has a value of more than 5.5 when dry and 3.5 when moist. The C horizon has a value of 7 or 8 when dry and 5 or 6 when moist and a chroma of 2 or 3. The Cca horizon ranges from 20 to 35 percent calcium carbonate.

Te—Thess silt loam (1 to 3 percent slopes). This nearly level and gently sloping soil is on broad terraces and fans. A few deep drainageways of intermittent streams dissect the terraces. This soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam, and the underlying material above the very gravelly sand is silt loam. The layer of very gravelly sand is at a depth of 15 to 30 inches.

Included with this soil in mapping are areas of Amesha and Scravo soils that make up about 20 percent of the mapping unit. Also included are areas of a Thess soil that has a surface layer of gravelly loam and silty clay loam and, in places, spots of an alkali-affected soil.

The hazard of soil blowing is severe. Runoff is medium.

This soil is used mainly for winter wheat and range. Some areas are irrigated. Capability units IIIe-2, dryland, and IIe-1, irrigated; Limy range site, 10- to 14-inch precipitation zone; windbreak suitability group 3L.

Ts—Thess-Scravo complex (0 to 2 percent slopes). This complex is about 60 percent Thess loam, 30 percent Scravo cobbly loam, and 10 percent very cobbly loam. These nearly level soils are on stream terraces. The Thess soil in this complex has the profile described as representative of the Thess series. The Scravo soils have profiles similar to the one described as representative of the Scravo series, but in places they are very cobbly. The Scravo soils occur throughout the complex in elongated areas that are as much as 50 acres in size. The Scravo very cobbly loam is in areas less than 20 acres in size.

The hazard of soil blowing is moderate to severe. Runoff is medium.

These soils are used mainly for irrigated alfalfa, wheat, and barley. Some areas are used for dryland winter wheat and range. Capability units IVs-2, dryland, and IIIs-1, irrigated; Thess loam in Limy range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3L; Scravo cobbly loam in Shallow to Gravel range site, 10- to 14-inch precipitation zone, and in windbreak suitability group 3M.

Tolman Series

The Tolman series consists of shallow, well-drained soils on uplands. These soils formed in calcareous channery and very channery loam residuum weathered from hard argillite. Slopes range from 10 to 35 percent. Elevation ranges from 3,800 to 5,000 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 90 to 120 days.

In a representative profile the surface layer is brown channery loam about 2 inches thick. The subsoil, about 5 inches thick, is brown heavy channery loam. The underlying material is pale-brown, strongly calcareous very

channery sandy clay loam. Argillite bedrock at at a depth of about 18 inches.

Permeability is moderate, and the available moisture capacity is very low.

Tolman soils are used for range.

Representative profile of Tolman channery loam, 10 to 35 percent slopes, 1,300 feet south and 800 feet west of the NE. corner of sec. 13, T. 6 N., R. 1 E.:

A1—0 to 2 inches, brown (10YR 5/3) channery loam, dark brown (10YR 3/3) moist; moderate, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; about 40 percent angular gravel; abrupt, smooth boundary.

B2t—2 to 7 inches, brown (10YR 5/3) heavy channery loam, dark brown (10YR 3/3) moist; moderate, medium, angular blocky structure; hard, friable, sticky and plastic; thick continuous clay films on peds; about 40 percent angular gravel; abrupt, smooth boundary.

Cca—7 to 18 inches, pale-brown (10YR 6/3) very channery sandy clay loam, brown (10YR 5/3) moist; massive; hard, friable, slightly sticky and slightly plastic; about 50 percent angular gravel; strongly effervescent; lime coatings on undersides of angular pebbles; abrupt, smooth boundary.

R—18 inches, argillite bedrock.

The solum ranges from 7 to 20 inches in thickness. Depth to argillite bedrock is less than 20 inches. The soil ranges from 35 to 50 percent angular gravel. The soil has a hue of 10YR or 7.5YR.

The A horizon has a value of 4 or 5 when dry and 2 or 3 when moist and a chroma of 2 or 3. The B2t horizon has a value of 4 or 5 when dry and 2 or 3 when moist and a chroma of 3 or 4. It has medium or fine, blocky structure and ranges from 30 to 35 percent clay. The Cca horizon has a value of 6 to 8 when dry and a chroma of 3 or 4. It ranges from very channery loam to very channery clay loam.

TtE—Tolman channery loam, 10 to 35 percent slopes. This hilly and steep soil is on mountainous uplands that have smooth, rounded ridges separated by deep drainageways. Most areas are several hundred acres in size.

Included with this soil in mapping, and making up about 30 percent of the mapped areas, are areas of Rencot and Rootel channery loams and Rock outcrop. The Rencot soil is within areas of the Tolman soil. The Rootel soil is in swales and on foot slopes. Rock outcrop is on ridgetops, points of hills, and some steep side slopes. Also included are areas of a soil that is similar to this Tolman soil but that is redder.

The hazard of erosion is severe. Runoff is rapid.

This soil is used only for range. Capability unit VIe-1, dryland; Shallow range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Toston Series

The Toston series consists of deep, somewhat poorly drained soils on low stream terraces and bottom lands. These soils formed in calcareous, strongly alkaline alluvium. Slopes range from 0 to 5 percent. Elevation ranges from 3,700 to 4,100 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

In a representative profile the surface layer is grayish-brown silty clay loam about 2 inches thick. The subsoil, about 6 inches thick, is gray silty clay. The underlying material to a depth of 34 inches is very pale brown and light-gray silty clay loam and silt loam. Below this, it is light-gray stratified loam, sandy loam, and loamy sand to a depth of 60 inches or more.

Permeability is slow, and the available moisture capacity is mostly high. A seasonal high water table is at a depth of 36 to 72 inches.

Toston soils are used mainly for range.

Representative profile of Toston silty clay loam (0 to 5 percent slopes), 2,100 feet west of the SE. corner of sec. 36, T. 5 N., R. 1 E.:

A1—0 to 2 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine pores; strongly alkaline; abrupt, smooth boundary.

B21t—2 to 4 inches, gray (10YR 6/1) silty clay, very dark gray (10YR 3/1) moist; moderate, medium, columnar structure parting to moderate, medium, platy; very hard, firm, sticky and plastic; few fine roots; many fine tubular pores; common moderately thick clay films on peds; common fine, soft masses and filaments of gypsum; strongly alkaline; clear, smooth boundary.

B22t—4 to 8 inches, gray (10YR 6/1) light silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, blocky structure; very hard, firm, sticky and plastic; organic stains on vertical faces of some peds; slightly effervescent; strongly alkaline; clear, smooth boundary.

C1cacs—8 to 16 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; weak, medium, blocky structure; hard, friable, sticky and plastic; many fine tubular pores; strongly effervescent; common fine, soft masses and filaments of gypsum; moderately alkaline; gradual, wavy boundary.

C2—16 to 34 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; common, fine, faint-brown mottles; massive; hard, very friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline; gradual, wavy boundary.

C3—34 to 60 inches, light-gray (2.5Y 7/2) thinly stratified loam, sandy loam, and loamy sand, grayish brown (2.5Y 5/2) moist; common, fine, distinct, brown (10YR 5/3) mottles; massive; hard, very friable, slightly sticky and nonplastic; strongly effervescent; moderately alkaline.

The solum ranges from 7 to 10 inches in thickness. Accumulations of gypsum range from common to many fine, soft masses and filaments in the upper 6 to 20 inches of the soil. The soil has a hue of 10YR or 2.5Y throughout.

The A and B horizons have a value of 5 or 6 when dry and 3 to 5 when moist and a chroma of 1 to 3. The B horizon has strong, columnar, prismatic or blocky structure. The C horizon has a value of 6 or 7 when dry and 3 to 5 when moist and a chroma of 1 to 3. It is stratified loamy sand to silty clay loam.

Tu—Toston silty clay loam (0 to 5 percent slopes). This nearly level and gently sloping and undulating soil is on low stream terraces and flood plains along the Missouri River and in the Crow Creek Valley. Many shallow, old watercourses traverse the area.

Included with this soil in mapping, and making up about 30 percent of the mapped areas, are areas of seeped and saline phases of Amesha, Thess, Fairdale, and Villy soils. The Fairdale and Villy soils are in the channel areas. The Thess and Amesha soils are in areas of Toston soils. Also included are areas of Toston soils that have a surface layer of loam, clay loam, and silty clay loam. In the Crow Creek Valley, the surface layer is dominantly silty clay loam, and along the Missouri River it is mostly loam and clay loam.

The hazard of erosion is slight to moderate. Runoff is medium to slow.

This soil is used mainly for grazing. Capability unit VIw-1, dryland; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Tropal Series

The Tropal series consists of shallow, well-drained soils on hilly and mountainous uplands. These soils formed in strongly calcareous gravelly to very gravelly loam residuum weathered from hard limestone rock. Slopes range from 15 to 60 percent. Elevation ranges from 4,800 to 6,000 feet. The average annual precipitation is 10 to 19 inches, and the frost-free season is 60 to 90 days.

In a representative profile the surface layer is grayish-brown gravelly loam about 2 inches thick. The underlying material is very pale brown, strongly calcareous gravelly and very gravelly loam. Limestone bedrock is at a depth of about 19 inches.

Permeability is moderate, and the available moisture capacity is very low.

Tropal soils are used for range.

Representative profile of Tropal gravelly loam in an area of Tropal-Rock outcrop complex, 15 to 60 percent slopes, 700 feet southeast of the NW. corner of sec. 10, T. 6 N., R. 1 E.:

A1—0 to 2 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable. slightly sticky and slightly plastic; many roots; strongly effervescent; thick lime coatings on undersides of pebbles and stones; abrupt, smooth boundary.

C1ca—2 to 7 inches, very pale brown (10YR 7/3) gravelly loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; slightly sticky and slightly plastic; many roots; 25 percent gravel; violently effervescent; thick lime coatings on undersides of pebbles; gradual, smooth boundary.

C2ca—7 to 19 inches, very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common roots; 55 percent gravel and cobbles; violently effervescent; gravel and cobbles coated with lime; abrupt, smooth boundary.

R—19 inches, limestone.

Depth to bedrock ranges from 7 to 20 inches. The soil ranges from 30 to 65 percent gravel and cobbles. The soil has a hue of 10YR or 2.5Y throughout.

The A horizon has a value of 5 or 6 when dry and 3 or 4 when moist and a chroma of 2 or 3. The Cca horizon has a value of 7 or 8 when dry and 5 to 7 when moist and a chroma of 2 or 3.

TvF—Tropal-Rock outcrop complex, 15 to 60 percent slopes. This complex is about 55 percent Tropal gravelly loam and Tropal stony loam and 30 percent Rock outcrop. These steep and very steep soils are on mountainous uplands. The Tropal soils are on mountainsides and smooth, convex areas. Rock outcrop is mainly on ridgetops, but it also is in isolated areas downslope. The Tropal gravelly loam in this complex has the profile described as representative of the Tropal series. The Tropal stony loam in this complex has a profile similar to the one described as representative of the Tropal series, but the surface layer is stony loam.

Included with these soils in mapping are areas of Crago and Whitore soils that make up about 15 percent of the mapping unit. The Crago soil is on foot slopes and in swales. The Whitore soil is mostly on north-facing slopes along drainageways.

The hazard of erosion is severe. Runoff is rapid.

These soils are used only for range. Capability unit VIIe-1, dryland; Tropal stony loam in Very Shallow range site, 10- to 19-inch precipitation zone, and in windbreak suitability group 4; Rock outcrop not assigned to a range site or wildlife suitability group.

Ustic Torrifluvents

Uf—Ustic Torrifluvents (1 to 3 percent slopes). These are nearly level or gently sloping, well-drained soils along narrow stream valleys. They are grayish-brown or light grayish-brown sandy loam or clay loam that is generally more than 36 inches deep over sand and gravel. The surface layer in about 25 percent of this mapping unit is 15 to 50 percent or more gravel. The soil surface is irregular because of the many low dissecting drainageways.

Most areas of this unit are subject to flooding at least once a year. The hazard of erosion is moderate to high, and runoff is medium.

This unit is used mainly for range. Some small areas are used for hay. Capability unit VIw-1, dryland; Overflow range site, 10- to 14- inch precipitation zone; windbreak suitability group 2W.

Ustic Torriorthents, Saline

Ut—Ustic Torriorthents, saline (0 to 5 percent slopes). These are nearly level to gently sloping, saline and saline-alkali soils on stream terraces. The surface layer ranges from sandy loam to clay loam on about 90 percent of the unit. On about 10 percent, it is gravelly loamy sand that occurs in narrow stringers throughout the unit. The soils are 20 to 40 inches deep over sand and gravel in about 75 percent of the acreage, more than 40 inches deep in 15 percent, and less than 20 inches deep in 10 percent. About 70 percent of the unit is moderately affected, 10 percent is severely affected, and 20 percent is slightly affected by salts.

Parts of this unit have a seasonal high water table at a depth of 30 to 60 inches and are subject to overflow. The hazard of erosion is moderate, and runoff is medium to slow.

This unit is used mainly for pasture. Capability unit VIw-1, dryland; Saline Lowland range site, 10- to 14-inch precipitation zone; windbreak suitability group 4.

Villy Series

The Villy series consists of deep, poorly drained soils on low stream terraces and bottom lands. These soils formed in calcareous, stratified silty clay loam and silt loam alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 3,700 to 4,500 feet. The average annual precipitation is 10 to 14 inches, and the frost-free period is 105 to 120 days.

In a representative profile the surface layer is light-gray silty clay loam about 7 inches thick. The underlying material is light-gray and gray stratified silty clay loam and silt loam to a depth of 60 inches or more.

Permeability is moderately slow, and the available moisture capacity is high.

Villy soils are used mostly for range. Some drained areas are used for irrigated crops.

Representative profile of Villy silty clay loam (0 to 2 percent slopes), 1,600 feet east and 400 feet south of the NW. corner of sec. 8, T. 6 N., R. 2 E.:

A1—0 to 7 inches, light-gray (10YR 6/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate, thin, platy structure; hard,

friable, sticky and plastic; many very fine roots; many very fine pores; moderately effervescent; moderately alkaline; clear, smooth boundary.

C1g—7 to 22 inches, light-gray (N 7/0) silty clay loam, gray (N 5/0) moist; massive; very hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine pores; strongly effervescent; moderately alkaline; clear, smooth boundary.

C2g—22 to 34 inches, gray (N 6/0) silt clay loam, dark gray (N 4/0) moist; massive; very hard, friable, sticky and plastic; few very fine roots; few very fine pores; strongly effervescent; moderately alkaline; gradual, smooth boundary.

IIA1bg—34 to 40 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline; clear, smooth boundary.

IIC3g—40 to 60 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) moist; massive; very hard, friable, sticky and plastic; strongly effervescent; moderately alkaline.

Between depths of 10 and 40 inches, the soil ranges from 18 to 35 percent clay. The soil has a hue of neutral to 10YR throughout.

The A horizon has a value of 6 or 7 when dry and 3 to 5 when moist and a chroma of 1 or 2. The Cg horizon has a value of 5 to 7 when dry and 3 to 6 when moist and a chroma of 1 or less. In places a layer of silty clay is below a depth of 40 inches. Also, a buried A horizon occurs in some places.

Va—Villy silty clay loam (0 to 2 percent slopes). This poorly drained, nearly level soil is on smooth stream terraces that are dissected by shallow channel meanders. This soil has the profile described as representative of the series.

Included with this soil in mapping, and making up about 10 percent of the mapped areas, are areas of very poorly drained soils along the drainageways.

The hazard of erosion is slight. Runoff is slow.

This soil is used mainly for pasture. Some of the grasses are harvested as wild hay. The soil has a water table mostly between depths of 0 and 20 inches and is saturated most of the year. Capability unit VIw-1, dryland; Wetland range site, 10- to 19-inch precipitation zone; windbreak suitability group 4.

Vd—Villy silty clay loam, drained (0 to 2 percent slopes). This nearly level soil is on smooth stream terraces. It has a profile similar to the one described as representative of the series, but the seasonal high water table is at a depth of 30 to 48 inches.

Included with this soil in mapping, and making up about 10 percent of the mapped areas, are areas of poorly drained soils in concave areas and drainageways.

The hazard of erosion is slight. Runoff is medium.

This soil is used for irrigated alfalfa, barley, and wheat. Capability unit IIIw-1, irrigated; Subirrigated range site, 10- to 14-inch precipitation zone; windbreak suitability group 2W.

Whitore Series

The Whitore series consists of deep, well-drained soils on mountainous uplands. These soils formed in residuum and colluvium weathered mainly from limestone rock. Slopes range from 25 to 60 percent. Elevation ranges from 5,000 to 7,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is less than 90 days.

In a representative profile a 2-inch layer of forest litter covers the surface layer of grayish-brown channery silt loam about 3 inches thick. The subsoil, about 11 inches thick, is light brownish-gray, calcareous channery loam. The underlying material is white, very strongly calcareous channery and very channery loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is mostly low.

Whitore soils are used for woodland grazing and some timber harvest.

Representative profile of Whitore channery silt loam, 25 to 60 percent slopes, 800 feet west of the E. quarter corner of sec. 18, T. 5 N., R. 1 W.:

O1—2 inches to 0, forest litter of pine needles, twigs, moss, etc.

A1—0 to 3 inches, grayish-brown (10YR 5/2) channery silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, platy structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; common roots; ped plates coated with bleached silt and sand grains; strongly effervescent; gradual, wavy boundary.

B2—3 to 14 inches, light brownish-gray (10YR 6/2) channery loam, dark grayish brown (10YR 4/2) moist; weak, medium, blocky structure parting to moderate, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; common roots; peds coated with bleached silt and sand grains; strongly effervescent; thick lime coating on sides and undersides of channers and cobbles; gradual, wavy boundary.

C1ca—14 to 40 inches, white (10YR 8/2) channery loam, pale brown (10YR 6/3) moist; weak, coarse, blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; about 45 percent limestone channers and cobbles; violently effervescent; thick lime coatings on sides and undersides of channers and cobbles; gradual, wavy boundary.

C2ca—40 to 60 inches, white (10YR 8/2) very channery loam; massive; few roots; 70 percent limestone channers and cobbles; violently effervescent; thick lime coatings on undersides of channers and cobbles.

Depth to bedrock is 40 to 60 inches or more. Angular gravel, cobbles, and stones range in volume from 15 to 30 percent in the A and B horizons to more than 60 percent in the lower part of the C horizon. The solum ranges from 10 to 18 inches in thickness.

The A horizon ranges from channery silt loam to stony loam. The A and B horizons when mixed to 7 inches have a hue of 10YR or 7.5YR, a value of 5 or 6 when dry and 4 or 5 when moist, and a chroma of 2 or 3. The C horizon has a hue of 2.5Y or 10YR, a value of 7 or 8 when dry and 5 to 7 when moist, and a chroma of 2 or 3.

WhF—Whitore channery silt loam, 25 to 60 percent slopes. This steep and very steep soil is on mountainous uplands.

Included with this soil in mapping, and making up about 15 percent of the mapped areas, are areas of Tropal very channery loam on ridgetops and south-facing slopes. Also included are areas of Rock outcrop on ridges and side slopes. Rock outcrop makes up about 5 percent of the acreage.

The hazard of erosion is severe. Runoff is rapid.

This soil is used mainly for woodland grazing. It supports an open stand of Douglas-fir. The site index is only 20 to 40 for the Douglas-fir, based on Brickell curves and a 50-year base. Use of logging equipment is limited on slopes of more than 30 percent. Capability unit VIe-1, dryland; range site and windbreak suitability group not assigned.

Windham Series

The Windham series consists of deep, well-drained soils on terrace edges and side slopes of deep drainageways. These soils formed in calcareous very gravelly or very cobbly loamy old alluvium. Slopes range from 9 to 35 percent. Elevation ranges from 4,500 to 5,000 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is 90 to 105 days.

In a representative profile the surface layer is dark gray-

ish-brown cobbly loam about 4 inches thick. The subsoil, about 5 inches thick, is brown cobbly clay loam. The underlying material is very pale brown, white, and light-gray, strongly calcareous very gravelly loam to a depth of 60 inches or more.

Permeability is moderate, and the available moisture capacity is low.

Windham soils are used for native range.

Representative profile of Windham cobbly loam, 9 to 35 percent slopes, 800 feet west of the E. quarter corner of sec. 10, T. 7 N., R. 3 E.:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; moderate, thin, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; clear, smooth boundary.

B21—4 to 6 inches, brown (10YR 5/3) cobbly clay loam, dark brown (10YR 3/3) moist; moderate, medium, blocky structure; hard, friable, sticky and plastic; many roots; slightly effervescent; clear, smooth boundary.

B22—6 to 9 inches, brown (10YR 5/3) cobbly clay loam, brown (10YR 4/3) moist;moderate, medium, blocky structure; hard, friable, sticky and plastic; common roots; slightly effervescent; gradual, smooth boundary.

C1ca—9 to 15 inches, very pale brown (10YR 7/3) very gravelly loam, brown (10YR 5/3) moist; weak, medium, blocky structure; slightly hard, very friable, sticky and slightly plastic; common roots; strongly effervescent; lime coatings on undersides of pebbles and cobbles; gradual, smooth boundary.

C2ca—15 to 45 inches, white (10YR 8/2) very gravelly loam, pale brown (10YR 6/3 and 7/3) moist; weak, medium and fine, blocky structure; slightly hard, very friable, sticky and slightly plastic; common roots to a depth of 30 inches, few below; 50 percent gravel and cobbles; violently effervescent; many medium, distinct, white lime nodules and lime coatings on pebbles and cobbles; gradual, wavy boundary.

C3—45 to 60 inches, light-gray (2.5Y 7/2) very gravelly loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, sticky and slightly plastic; few roots; 60 percent gravel and cobbles; violently effervescent.

In places very gravelly loamy sand is below a depth of 40 inches. The soil has a hue of 10YR to 2.5Y throughout.

The A horizon has a value of 4 or 5 when dry and 2 or 3 when moist. The B2 horizon has a value of 4 or 5 when dry and 3 or 4 when moist and a chroma of 2 or 3. It ranges from 28 to 35 percent clay. It has blocky or prismatic structure. The Cca horizon has a value of 7 or 8 when dry and 5 to 7 when moist and a chroma of 2 or 3. It ranges from 20 to 40 percent calcium carbonate.

WnE—Windham cobbly loam, 9 to 35 percent slopes. This moderately steep and steep soil is on terrace edges and sides of deep drainageways.

Included with this soil in mapping, and making up about 40 percent of the mapped areas, are areas of Crago cobbly loam, Crago stony loam, Martinsdale cobbly loam and some loamy soils derived from alluvium along the narrow stream bottoms. The Crago soils are in 1- to 10-acre areas within larger areas of Windham soils. The Martinsdale soil is commonly on the lower, less sloping areas. Also included are some areas of Rock outcrop.

The hazard of erosion is severe. Runoff is rapid.

This soil is used for range. Capability unit VIe-1, dryland; Silty range site, 15- to 19-inch precipitation zone; windbreak suitability group 4.

Woodrock Series

The Woodrock series consists of moderately deep, well-drained soils on hilly and mountainous uplands. These soils formed in noncalcareous, arkosic, loamy residuum weathered from coarse-grained igneous rock. Slopes range from 15 to 60 percent. Elevation ranges from 4,500 to 6,500 feet. The average annual precipitation is 15 to 19 inches, and the frost-free period is less than 90 days.

In a representative profile the surface layer is very dark gray gravelly sandy loam about 1 inch thick. The subsurface layer is light brownish-gray gravelly sandy loam about 5 inches thick. The subsoil, about 17 inches thick, is grayish-brown and yellowish-brown gravelly sandy clay loam. Weathered granodiorite rock is at a depth of about 23 inches. It grades into hard rock at a depth of about 32 inches.

Permeability is moderate, and the available moisture capacity is low or very low.

Woodrock soils are used for woodland grazing and wildlife habitat.

Representative profile of Woodrock gravelly sandy loam in an area of Woodrock-Loberg complex, 15 to 60 percent slopes, near the center of sec. 32, T. 9 N., R. 1 W.:

O1&O2—3 inches to 0, undecomposed and partly decomposed forest litter.

A1—0 to ½ inch, very dark gray (10YR 3/1) gravelly sandy loam, black (10YR 2/1) moist; moderate, fine, granular structure; soft, very friable, slightly sticky and nonplastic; 15 percent gravel; slightly acid; abrupt, smooth boundary.

A2—½ inch to 6 inches, light brownish-gray (2.5Y 6/2) gravelly sandy loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and thin, platy structure; soft, very friable, slightly sticky and nonplastic; 20 percent gravel; slightly acid; diffuse, irregular boundary.

B2t—6 to 23 inches, grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/4) gravelly sandy clay loam, dark grayish brown (2.5YR 4/2) and brown (10YR 4/3) moist; moderate, coarse, subangular blocky structure; very hard, friable, sticky and plastic; many fine pores; moderate patchy clay films on vertical surfaces of peds; 25 percent gravel; slightly acid; gradual, wavy boundary.

C—23 to 32 inches, weathered granodiorite rock; diffuse, wavy boundary.

R—32 inches, hard bedrock.

Depth to bedrock ranges from 20 to 40 inches. The soil contains 15 to 25 percent gravel throughout the profile. The soil has a hue of 10YR or 2.5Y throughout.

The A1 horizon has a value of 3 or 4 when dry and 1 to 3 when moist and a chroma of 1 or 2. The A2 horizon has a value of 6 or 7 when dry and 4 or 5 when moist and a chroma of 1 or 2. The B2t horizon has a value of 4 or 5 when dry and a chroma of 2 to 4. It has blocky or prismatic structure. In some places an A&B horizon overlies the B2t horizon, and in others a B3 horizon of sandy loam or sandy clay loam underlies the B2t horizon.

WoF—Woodrock-Loberg complex, 15 to 60 percent slopes. This complex is about 60 percent Woodrock gravelly sandy loam and 30 percent Loberg very stony loam. These steep and very steep soils are on mountainous uplands. The Woodrock soil in this complex has the profile described as representative of the Woodrock series. It is mostly on the steeper parts of the landscape. The Loberg soil is on the less sloping foot slopes, downslope from the Woodrock soil.

Included with these soils in mapping, and making up about 10 percent of the mapped areas, are areas of Rock outcrop that are almost entirely within areas of very steep Woodrock soils on slopes and ridgetops.

The hazard of erosion is severe. Runoff is rapid.

These soils are used mainly for woodland. Some areas are grazed by wildlife and livestock. The Loberg soil in this complex supports stands of Douglas-fir or lodgepole pine and only a few other species. The stands are well stocked and of mixed age classes. The site index is 35 to 45 for the Douglas-fir, based on Brickell curves and a 50-year base.

There are no special hazards or limitations in using this soil for woodland, except where slopes are more than 30 percent. Forest products are used mainly for production of sawlogs, posts, and poles. The Woodrock soil in this complex supports a mixed stand of Douglas-fir, lodgepole pine, and some associated species. The stands are of mixed age classes. The site index is only 20 to 35 for the Douglas-fir, based on Brickell curves and a 50-year base. Use of logging equipment is limited on slopes of more than 30 percent. Capability unit VIe-1; dryland; range site and wildlife suitability group not assigned.

WrE—Woodrock-Rock outcrop complex, 15 to 35 percent slopes. This complex is about 65 percent Woodrock stony loam and 20 percent Rock outcrop. These steep and very steep soils are on mountainous uplands. The Woodrock soil in this complex has a profile similar to the one described as representative of the Woodrock series, but it is shallower over bedrock. It is on steep side slopes and in saddles. Rock outcrop is mostly on ridgetops and points of hills.

Included with these soils in mapping, and making up about 15 percent of the mapped areas, are areas of Rooset stony loam and some stony loams that are less than 20 inches deep over bedrock.

The hazard of erosion is severe. Runoff is rapid.

These soils are used mainly for woodland and some woodland grazing. The Woodrock soil supports a mixed stand of Douglas-fir and lodgepole pine and some associated species. The site index is only 20 to 35 for the Douglas-fir, based on Brickell curves and a 50-year base. Use of logging equipment is limited on slopes of more than 30 percent. Capability unit VIe-1, dryland; range site and wildlife suitability group not assigned.

Use and Management of the Soils

This section contains information about the use and management of the soils of the Broadwater County Area for crops, range, engineering, and recreation. Information is given about woodland use and management, where applicable, in the section "Descriptions of the Soils."

General Management of Cropland

Approximately 20 percent of the acreage in the Broadwater County Area is cultivated. About 40,000 acres is irrigated, and 70,000 acres is dryfarmed. The dryland areas are used mainly for winter wheat and barley. The irrigated land is used for sugar beets, hay, pasture, and some potatoes.

Irrigation water is adequate for irrigated crops most years, but conservation of water is essential to successful farming in the survey area. Irrigation water is applied in rows, corrugations, and borders or by sprinklers. Different methods of irrigation, along with control of drainage and land leveling, are needed on different fields and must be compatible with the soils irrigated. Most difficulties involved with irrigation can be solved in a practical way if the topography, water needs, and suitability of the soil for irrigation are known.

The objective of irrigation is to apply water in such a way that the soil is wet to the rooting depth of plants and that a minimum amount of water is lost through runoff and deep percolation. Judicious use of irrigation water assures high production, conserves irrigation water, reduces soil erosion, and reduces waterlogging, salt accumulation, and other adverse conditions common in irrigated soils. Drainage is important on wet and salty soils and in some areas must be provided artificially if the soils are to be productive. Where feasible, all crop residue should be returned to the soil.

The cropping system followed on dryland soil is small grains and fallow in alternate years. The main consideration in dryland farming is conserving available moisture. Soils are cultivated during the fallow year to kill weeds, to conserve as much of the fallow year's precipitation as possible for the grain crop the following year, and to increase available nitrogen in the soil. Tillage operations that leave crop residue on the surface and produce a rough or cloddy surface protect the soil from wind, reduce evaporation of soil moisture, increase water infiltration, and keep the soil particles in place. Additional measures that help protect the soil from soil blowing and water erosion and help conserve available moisture are contour farming, stripcropping, windbreaks, buffer strips, timely tillage, and minimum tillage.

Use of commercial fertilizer in the Broadwater County Area has increased steadily. Dryland wheat and barley respond well to applications of nitrogen and phosphorus fertilizer if the soil is moist to a depth of 30 inches or more at the time of seeding. Applications of commercial fertilizer for irrigated crops are more variable than for dryland crops. Applications are tailored to the specific needs of the crop grown. Soil tests are needed, and experiment station and extension service recommendations should be consulted for applications of commercial fertilizer to irrigated land.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These groups are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I to VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture, range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold to too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol; for example, IIe-1 or IIIs-1. Thus, in one symbol the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic number specifically identifies the capability unit within each subclass.

In the following pages the irrigated and dryland capability units in the Broadwater County Area are described, and suggestions for the use and management of the soils are given. To find the unit in which a given soil has been placed, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIIe-2, DRYLAND

This unit consists of well drained and moderately well drained soils that have a surface layer of sandy loam to clay loam. In places this layer is gravelly or cobbly. The soils that have a surface layer of loam, silt loam, and silty clay are limy. Slopes are 0 to 5 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

Permeability is moderately rapid to moderate. Runoff is medium to very slow, and the hazard of erosion is slight to high. Available moisture capacity is low to high.

These soils are used mainly for winter wheat or barley in a crop-fallow system. Wind stripcropping, field windbreaks, leaving crop residue on the surface, and tillage practices that leave the surface rough help to reduce soil blowing and runoff. Grassed waterways are also helpful in reducing erosion caused by runoff. Crops respond to applications of nitrogen and phosphorus fertilizer if the soils are moist to a depth of 30 inches or more at the time of seeding.

CAPABILITY UNIT IIIe-4, DRYLAND

This unit consists of well-drained soils that have a surface layer of sandy loam to silty clay. In places this layer is gravelly, channery, or cobbly. Slopes are 3 to 10 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

Permeability is slow to moderately rapid. Runoff is very slow to rapid, and the hazard of erosion is moderate to high. Available moisture capacity is low to high.

These soils are used mainly for winter wheat or barley in a crop-fallow system. Wind stripcropping, contour farming, leaving crop residue on the surface, and tillage practices that leave the surface rough help to reduce erosion. Field windbreaks help to reduce soil blowing, and grassed waterways help to reduce erosion caused by runoff. Crops respond to applications of nitrogen and phosphorus fertilizer if the soils are moist to a depth of 30 inches or more at the time of seeding.

CAPABILITY UNIT IIIe-6, DRYLAND

This unit consists of well-drained soils that have a surface layer of loam to cobbly loam. Slopes are 2 to 9 percent. The average annual precipitation is 15 to 19 inches, and the frost-free season is 90 to 105 days.

Permeability is moderate. Runoff is medium, and the hazard of erosion is slight to moderate. Available moisture capacity is high.

These soils are used mainly for winter wheat or barley in a crop-fallow system. Erosion caused by runoff is the main limitation, especially on slopes of more than 5 percent. Contour farming, leaving crop residue on the surface, and grassed waterways help to reduce runoff and conserve moisture. Crops respond to applications of nitrogen and phosphorus fertilizer if the soils are moist to a depth of 30 inches or more at the time of seeding.

CAPABILITY UNIT IVe-2, DRYLAND

This unit consists of well-drained soils that have a surface layer of silt loam, cobbly loam, or channery silt loam. Slopes are 5 to 15 percent. The average annual precipitation is 15 to 19 inches, and the frost-free season is 60 to 90 days.

Permeability is moderate. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Available moisture capacity is very low to moderate.

These soils are used mainly for winter wheat or barley in a crop-fallow system. They are also used for alfalfa and range. Contour cropping, leaving crop residue on the surface, tillage practices that leave the surface rough, and grassed waterways help to reduce erosion caused by runoff. Timely farm operations are needed because the growing season is short. Crops respond well to applications of nitrogen and phosphorus fertilizer if the soils are moist to a depth of 30 inches or more at the time of seeding.

CAPABILITY UNIT IVs-2, DRYLAND

This unit consists of well-drained soils that have a surface layer of sandy loam, loam, gravelly loam, very cobbly loam, and cobbly loam. Slopes are 0 to 9 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is moderately rapid to moderate in the upper 15 to 20 inches and moderately rapid to rapid below. Runoff is very slow to medium, and the hazard of erosion is moderate and high. Available moisture capacity is low.

These soils are used for winter wheat, spring wheat, or barley in a crop-fallow system. They are droughty soils and are marginal for dryland crops. When the annual precipitation is above normal, yields of small grains are fair. Use of commercial fertilizer on these soils is questionable because the soils have low available moisture capacity and are droughty.

CAPABILITY UNIT VIe-1, DRYLAND

This unit consists of well-drained soils that have a surface layer of loamy sand to silty clay. This layer ranges from gravelly to extremely stony. Slopes are 1 to 60 percent. The average annual precipitation is 10 to 19 inches, and the frost-free season is 60 to 120 days.

Permeability is moderately rapid to slow. Runoff is very slow to very rapid, and the hazard of erosion is moderate to high. Available moisture capacity is very low to high.

These soils are used mostly for range. Some areas are used for woodland. Management of these soils for woodland is described in the section"Descriptions of the Soils." For all other soils in this unit, refer to the appropriate range site description for management of range.

CAPABILITY UNIT VIw-1, DRYLAND

This unit consists of somewhat poorly drained and poorly drained soils that have a surface layer of sandy loam to silty clay loam. Included in this unit are some well-drained soils that are subject to flooding. These layers range from gravelly to very cobbly. Slopes are 0 to 5 percent. The average annual precipitation is 10 to 19 inches, and the frost-free season is 90 to 120 days.

Permeability is moderate to slow. Runoff is medium to slow, and the hazard of erosion is slight to severe. Available moisture capacity is low to high. A seasonal high water table ranges from near the surface to a depth of 60 inches. Some areas are subject to overflow.

These soils are suitable only for range. If drained, some would be suitable for cultivation. Deferred grazing, applications of fertilizer, and seeding are practical on some of these soils.

CAPABILITY UNIT VIs-1, DRYLAND

This unit consists of moderately well drained to somewhat excessively drained soils that have a surface layer of sandy loam or loam. This layer is gravelly, cobbly, very cobbly, and extremely stony. Slopes are 0 to 35 percent. The average annual precipitation is 10 to 19 inches, and the frost-free season is 60 to 120 days.

Permeability is rapid to moderate. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Available moisture capacity is very low to moderate.

These soils are used mostly for range. Some small areas of nearly level to sloping soils are used for irrigated alfalfa and pasture.

CAPABILITY UNIT VIIe-1, DRYLAND

This unit consists of well-drained soils that have a surface layer of clay loam and loam. In places this layer is gravelly or stony. Slopes are 9 to 60 percent. The average annual precipitation is 10 to 19 inches, and the frost-free season is 60 to 120 days.

Permeability is moderate. Runoff is rapid, and the hazard of erosion is severe. Available moisture capacity is very low.

These soils are used only for range.

CAPABILITY CLASS VIII, DRYLAND

This class consists of areas of waste rock from ore mines; of areas where the original soil has been disturbed, overturned, or removed in placer mining, leaving an uneven or rough and scarred surface; and of Rock outcrop.

CAPABILITY UNIT IIe-1, IRRIGATED

This unit consists of well-drained soils that have a surface layer of sandy loam to clay loam. In places gravel or cobbles are on the surface and throughout the profile. Slopes are 1 to 5 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

Permeability is moderate to moderately rapid. Runoff is very slow to medium. The hazard of erosion is slight to moderate, and the hazard of soil blowing is severe on some soils. Available moisture capacity is low to high.

These soils are used mainly for irrigated alfalfa, sugar beets, potatoes, barley, oats, and corn silage. Most of the soils are easily tilled and respond to good farming practices. Land leveling exposes layers of high lime content on some of these soils. Areas where lime has been exposed require heavy applications of manure, green-manure crops, and fertilizer.

CAPABILITY UNIT IIs-1, IRRIGATED

Lothair silty clay, the only soil in this unit, is a well-drained soil that is silty clay throughout. Slopes are 0 to 2 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is slow. Runoff is medium, and the hazard of erosion is slight. Available moisture capacity is moderate.

The soil in this unit is used mainly for irrigated alfalfa and barley. Because the surface layer is silty clay, the soil is difficult to cultivate. Tilling the soil when it is too dry or too wet produces large clods.

CAPABILITY UNIT IIc-1, IRRIGATED

This unit consists of well-drained soils that have a surface layer of loam or silt loam. In places sandy loam that is as much as 35 percent gravel is below a depth of 40 inches. Slopes are 0 to 2 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is moderate. Runoff is medium. The hazard of erosion is slight, and the hazard of soil blowing is moderate to severe. Available moisture capacity is moderate to high.

These soils are used mainly for irrigated alfalfa, wheat, sugar beets, potatoes, and barley. They are easily tilled and respond to good farming practices.

CAPABILITY UNIT IIIe-1, IRRIGATED

This unit consists of well-drained soils that have a surface layer of sandy loam to clay loam. In some soils this layer is gravelly or cobbly. Slopes are 4 to 9 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

Permeability is moderately rapid or moderate. Runoff is slow to medium. The hazard of erosion is mostly moderate, but in places the hazard of soil blowing is severe. Available moisture capacity is low to high.

These soils are used mainly for irrigated alfalfa, wheat, and barley. They respond to good farming practices. Contour border dikes and contour ditches are spaced closer on these gently sloping and sloping soils than on others to help control erosion and to provide more uniform irrigation.

CAPABILITY UNIT IIIe-3, IRRIGATED

This unit consists of well-drained soils that have a surface layer of loamy sand to loam. In some soils this layer is gravelly or cobbly. Slopes are 1 to 9 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is moderate to moderately rapid. Runoff is slow or medium. The hazard of soil blowing is moderate to severe, and the hazard of erosion is slight to moderate. Available moisture capacity is low or moderate.

These soils are used mainly for irrigated alfalfa, wheat, barley, and potatoes. Soils in this unit that are coarse textured and shallow over sandy gravel require more frequent irrigation than others. During land-leveling operations care should be taken not to expose and scatter excess amounts of cobbles and gravel.

CAPABILITY UNIT IIIe-5, IRRIGATED

This unit consists of well-drained soils that have a surface layer of loam and cobbly loam. Slopes are 2 to 9 percent. The average annual precipitation is 15 to 19 inches, and the frost-free season is 90 to 105 days.

Permeability is moderate. Runoff is medium, and the hazard of erosion is slight to moderate. Available moisture capacity is high. Natural fertility is moderately high to high.

These soils are used mainly for irrigated alfalfa, wheat, and barley. They respond to good farming practices. During land-leveling operations care should be taken not to expose and scatter excess amounts of cobbles.

CAPABILITY UNIT IIIw-1, IRRIGATED

This unit consists of somewhat poorly drained soils that have a surface layer of loam to silty clay. Slopes are 0 to 2 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is slow to moderate. Runoff is medium. The hazard of erosion is slight, but the hazard of soil blowing in places is severe. Available moisture capacity is moderate or high. The seasonal high water table is at a depth of 30 to 36 inches.

These soils are used for irrigated alfalfa, wheat, barley, and pasture. Because of the seasonal high water table, alfalfa is shorter lived on these soils than on well-drained soils. Rotation systems with alfalfa are shorter.

CAPABILITY UNIT IIIs-1, IRRIGATED

Thess-Scravo complex, the only mapping unit in this capability unit, consists of well-drained to somewhat excessively drained soils that have a surface layer of loam to cobbly loam and very cobbly loam. Slopes are 0 to 2 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is moderate in the surface layer and moderately rapid and rapid in the underlying material. Runoff is medium, and the hazard of erosion is none to slight. Available moisture capacity is mostly low.

These soils are used for alfalfa, pasture, and spring wheat. Because of their low available moisture capacity, careful control of irrigation water is important. Moderately light and frequent applications of irrigation water are a satisfactory means of reducing loss of fertility and of irrigation water by deep percolation. In many areas land leveling improves the efficiency of irrigation. Deep cuts should be avoided in land-leveling operations because the cobbly loamy sand and sand underlying material may be exposed.

CAPABILITY UNIT IVe-1, IRRIGATED

This unit consists of well-drained soils that have a surface layer of silt loam and cobbly loam. Slopes are 5 to 15 percent. The average annual precipitation is 15 to 19 inches, and the frost-free season is 60 to 90 days.

Permeability is moderate. Runoff is medium to rapid, and the hazard of erosion is moderate to severe. Available moisture capacity is moderate to high.

These soils are used for irrigated alfalfa and pasture. They respond to good farming practices. These sloping to moderately steep soils require careful control of irrigation water to help control erosion. Seeding grasses along with alfalfa reduces erosion by irrigation water. Irrigation by surface flooding requires that small heads of water be used and that length of runs be short. In some areas land smoothing improves the efficiency of irrigation.

CAPABILITY UNIT IVs-1, IRRIGATED

This unit consists of somewhat excessively drained soils that have a surface layer of cobbly loam. Slopes are 0 to 2 percent. The average annual precipitation is 10 to 14 inches, and the frost-free season is 105 to 120 days.

Permeability is moderate to a depth of about 17 inches and rapid below. Runoff is medium to slow, and the hazard of erosion is slight. Available moisture capacity is low or very high.

These soils are used only for irrigated hay and pasture, except where they occur in areas of irrigated cropland. Because of the very low or low available moisture capacity of these soils, careful control of irrigation water is important. Light and frequent applications are more suitable than others. Because these soils are shallow over sand and gravel, land-leveling operations should be restricted to the smoother areas so as not to expose the sand and gravel.

Predicted Yields [2]

Table 2 shows for each arable soil the average yield per acre of the principal crops under an improved or high level of management.

The yields shown in table 2 are based on farm records; on interviews with farmers, Soil Conservation District Supervisors, and members of the staff of the Montana Agricultural Experiment Station; and on direct observations. Considered in making the production estimates were the prevailing climate, the characteristics of the soils, and the influence of different kinds of management on the soils.

It should be understood that these yield figures are not intended to apply directly to specific tracts of land for any particular year, because the soils vary somewhat from place to place, management practices differ from farm to farm, and weather conditions differ from year to year. Nevertheless, these estimates appear to be as accurate a guide as can be obtained without a detailed and lengthy investigation. They are useful in showing the relative productivity of the soil.

The following practices are assumed to be part of an improved or high level of management: using cropping systems that maintain tilth and organic-matter content; controlling erosion to the maximum extent feasible, so that the quality of the soil is maintained or improved rather than reduced; maintaining a high level of fertility by means of soil tests and use of fertilizer in accordance with recommendations of the Montana Agricultural Experiment Station; using crop residue to the fullest extent practicable to protect and improve the soil; following minimum tillage practices where needed because of the hazards of compaction and erosion; using only the crop varieties that are best adapted to the climate and the soil; controlling weeds carefully by tillage and spraying; drainage to prevent seasonal high water tables and ponding so that wetness does not restrict yields of adapted crops; management to provide optimum conservation and use of both annual precipitation and irrigation water.

Use of the Soils for Range [3]

Lands that produce native vegetation dominated by grasses, forbs, and shrubs are called range. Approximately 68 percent of the land privately owned in the Broadwater County Area is used for range. These lands furnish a major part of the forage for livestock and big game. They also have value for recreation, scenic beauty, botanical reference, historical reference, and wildlife habitat. Income from livestock and livestock products contributes about 72 percent of the farm income for the survey area. Range forage production is a major crop in the economy.

From early settlement in about 1865 until about 1950, range in the Broadwater County Area was overgrazed. Since 1950, vegetation on much of the range has improved in condition. This improvement is largely because of improvements in range management.

Range sites and condition classes

Soils that have the capacity to produce the same kinds, amount, and proportions of range plants are grouped into range sites. A range site is the product of all environmental factors responsible for its development.

A plant community within a range site that has not undergone abnormal disturbance is the potential, or climax, plant community for that site. Climax plant communities are not precise or fixed in their composition. They vary, within reasonable limits, from year to year and from place to place.

Abnormal disturbance, such as overuse by livestock, excessive burning, erosion, or plowing, results in changes in the climax plant community or even in complete destruction of it if disturbance is drastic enough. If the range site has not deteriorated significantly under such disturbance, secondary plant succession progresses in the direction of the natural potential, or climax, plant community for the site.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in *excellent* condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in *good* condition if the percentage is 51 to 75; in *fair* condition if the percentage is 26 to 50; and in *poor* condition if the percentage is less than 25.

When changes occur in the climax plant community because of use by livestock or disturbance, some plant species increase and others decrease. The species increasing or decreasing depend upon the grazing animal, season of use, and degree of use. By comparing the composition of the present plant community to that of the climax plant community, it is possible to see how individual species have increased and others decreased. Plants that are not present in the climax community but that show up in the present plant community are invaders for the site.

The composition of the climax and present plant communities, together with other range site information, provide the basis for selecting range management systems.

Management of range

Management programs on range usually try to increase desirable plants and restore the range to as near climax condition as possible. Some programs are designed to create or maintain plant communities somewhat removed from the climax plant community to fit specific needs in the grazing program, to provide for wildlife habitat, or for other benefits. Any management objective should be compatible with conservation objectives.

---

[2] RAYMOND A. GROSSMAN, district conservationist, Soil Conservation Service, helped prepare this section.

[3] By HARRY CORRY, range conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre*

[Absence of a yield figure indicates that the soil is not suitable for the crop or

Soil	Wheat (Dryland)	Spring wheat		Barley
		(Dryland)	(Irrigated)	(Dryland)
	Bu	*Bu*	*Bu*	*Bu*
Abor silty clay, 3 to 9 percent slopes	30	28		37
Amesha sandy loam, 1 to 4 percent slopes	29	26	50	36
Amesha sandy loam, 4 to 9 percent slopes	25	23	43	34
Amesha cobbly sandy loam, 1 to 4 percent slopes	27	25	43	35
Amesha loam, 1 to 4 percent slopes	30	25	45	36
Amesha loam, 4 to 9 percent slopes	28	25	42	34
Bridger cobbly loam, 5 to 15 percent slopes	40	35	50	60
Bridger silt loam, 5 to 15 percent slopes	40	35	50	60
Brocko silt loam, 0 to 2 percent slopes	31	28	60	38
Brocko silt loam, 2 to 5 percent slopes	31	27	57	38
Brocko silt loam, 5 to 9 percent slopes	29	25	52	36
Brocko silt loam, wet, 0 to 2 percent slopes			48	
Chinook sandy loam, 1 to 4 percent slopes	29	27	55	36
Chinook sandy loam, 4 to 9 percent slopes	29	27	50	36
Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes			45	
Chinook-Crago loamy sands, 1 to 9 percent slopes			30	
Chinook-Crago complex, 5 to 9 percent slopes	24	22	38	32
Crago complex, 4 to 9 percent slopes	15	13	40	24
Delphill loam, 2 to 5 percent slopes	27	24		30
Fairdale silt loam			60	
Fairdale-Lothair silty clays			60	
Havre loam	29	27	60	36
Lothair silty clay			60	
Martinsdale loam, 2 to 5 percent slopes	35	34	50	48
Martinsdale loam, 5 to 9 percent slopes	38	36	58	50
Martinsdale cobbly loam, 2 to 9 percent slopes	36	34	50	48
Mussel loam, 0 to 2 percent slopes	29	27	60	36
Mussel loam, 2 to 5 percent slopes	27	25	55	33
Mussel-Crago complex	25	23	50	30
Mussel-Musselshell complex, 2 to 5 percent slopes	26	24	52	32
Mussel-Musselshell complex, 5 to 9 percent slopes	26	24	45	32
Musselshell gravelly loam, 2 to 5 percent slopes	25	23	50	30
Musselshell gravelly loam, 5 to 9 percent slopes	25	23	43	28
Musselshell-Thess cobbly loams, 3 to 8 percent slopes	20	18	35	28
Passcreek channery silt loam, 6 to 15 percent slopes	35	32		50
Rootel channery loam, 3 to 9 percent slopes	20	16		26
Sappington clay loam, 2 to 5 percent slopes	35	33	57	45
Sappington clay loam, 5 to 9 percent slopes	35	33	52	45
Sappington gravelly clay loam, 2 to 5 percent slopes	35	33	57	45
Sappington gravelly clay loam, 5 to 9 percent slopes	35	33	52	45
Scravo cobbly loam				
Thess silt loam	20	18	47	29
Thess-Scravo complex	18	16	44	27
Villy silty clay loam, drained			60	

Basically, a management program on range includes three groups of practices. They are vegetation management practices, stock control practices, and special improvement practices.

Vegetation management practices are the most important in any range management program. Proper grazing use, deferred grazing, rotation deferred grazing, and rest rotation grazing are the most important. Research and rancher experience have shown that if approximately half of the present season's growth of the key species for the desired use is harvested each year, range vegetation in good or excellent condition can be maintained, and range vegetation in fair condition can be improved. The half of the current year's production that is not grazed serves several purposes. It enables the plant to manufacture food for growth, root development, and storage. This maintains the vigor of the desirable plants and prevents them from being replaced by less desirable plants and weeds. It also protects the soil from soil blowing and erosion and, when returned to the soil, serves as mulch. This mulch improves soil tilth, permits rapid water absorption, and reduces runoff.

Stock control practices include fencing, salting, use of mineral supplements, water development, riding or herd-

of crops under a high level of management

that the crop is not generally grown on the soil. Only arable soils are listed]

Barley—Continued (Irrigated)	Sugar beets (Irrigated)	Potatoes (Irrigated)	Potatoes (Dryland)	Alfalfa (Irrigated)	Wild hay (Irrigated and subirrigated)
Bu	*Tons*	*Cwt*	*Tons*	*Tons*	*Tons*
75	16.0	350		5.5	
68	14.0	300		4.5	
70	16.0	325		4.5	
80	16.0	375		5.5	
70	14.0			4.5	
77			3	4.5	
77			3	4.5	2
90	19.0	350		6.0	
85	16.5	375		5.5	
75	15.0	350		4.5	
70	16.0	280		4.5	
80	17.0	400		4.5	
72	15.0	375		3.5	
70	14.5	350		4.5	
60	14.0	350		3.5	
63	14.5	300		3.5	
68	13.5	225		3.0	
90	17.0	350		6.0	2
90	17.0			6.0	2
90	17.0	350		6.0	
90	16.0			6.0	
75				5.0	
85				5.5	
75				5.0	
90	17.0	350		6.0	
85	16.5	335		5.5	
78	15.0	300		5.0	
80	15.5	325		5.5	
72	14.5	300		4.5	
78	15.0	300		5.0	
70	14.5	275		4.5	
60				4.0	
			2		
85				5.5	
78				4.5	
85				5.5	
78				4.5	
				3.5	
75	15.5	350		4.5	
70	14.0	275		4.0	
90	16.0	300		6.0	

ing, and livestock pest control. One or more of these practices are generally needed to obtain uniform distribution of grazing use over a range area. In effect, they are an essential means of achieving a good forage management program.

Special improvement practices are those that may be needed in instances where other management practices do not achieve the desired results or where recovery is too slow from forage management alone. These practices include range seedings, brush control, shallow chiseling, scalping, and fertilization. Range renovation practices, such as chiseling and brush control, must be followed by resting or deferred grazing. This allows the desirable plants to recover vigor or re-establish themselves. If the desired vegetation is depleted to the point that not enough of the better grasses are present to reestablish themselves, they are seeded. A good seedbed should be prepared and the seeded area deferred from grazing until grasses have been established.

Descriptions of range sites

In the following pages the seventeen range sites in the Broadwater County Area are described and the species composition of the potential, or climax, plant community

is listed. Also, the average annual production of air-dry herbage, in pounds per acre, for the potential plant community is given. Such annual production fluctuates with growing conditions from year to year, and the production is shown for both unfavorable years and favorable years. A brief description of changes in vegetative composition as a result of heavy grazing use is also included for each site. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

STONY RANGE SITE, 15- TO 19-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of very cobbly to extremely stony loam. The subsoil and underlying material are very cobbly or very stony loam, clay loam, and sandy loam. Slopes are 2 to 60 percent. The average annual precipitation is 15 to 19 inches.

Permeability is moderate. Available moisture capacity is low to moderate.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	45
Green and Columbia needlegrass	15
Idaho fescue	10
Forbs	5
Rough fescue	5
Shrubby cinquefoil	5
Western and thickspike wheatgrasses	5
Sedges	4
Needleandthread	3
Timber danthonia	3
Sandberg bluegrass	trace
Other woody species	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,200 pounds per acre in years of favorable moisture conditions and 1,400 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, such taller grasses as bluebunch wheatgrass, green and Columbia needlegrass, and rough fescue decrease. Increasers on this site are western and thickspike wheatgrass, Idaho fescue, Sandberg bluegrass, forbs, and woody species. If overgrazing continues, the site is invaded by broom snakeweed, rabbitbrush, curlycup gumweed, annual grasses and forbs, noxious weeds, and such tame grasses as timothy, smooth brome, and Kentucky bluegrass.

This site responds well to such management practices as proper grazing use and deferred grazing, and improvement in range conditions can be rapid. The high percentage of stones and cobbles in the surface layer restricts the use of mechanical range treatments and range seeding on the soils in this site.

VERY SHALLOW RANGE SITE, 10- TO 19-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of gravelly to stony loam. The underlying material is very gravelly to stony loam that rests on hard rock at a depth of less than 20 inches. Few roots penetrate to a depth of more than 10 inches. Outcrops of bedrock are characteristic. Slopes are 15 to 60 percent. The average annual precipitation is 10 to 19 inches.

Permeability is moderate. Available moisture capacity is very low.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	55
Western wheatgrass	10
Plains muhly	10
Forbs	5
Curlleaf mountainmahogany	5
Conifers	5
Other woody species	5
Skunkbush sumac	3
Sand dropseed	2
Prairie junegrass	trace
Plains reedgrass	trace
Blue grama	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 550 pounds per acre in years of favorable moisture conditions and 300 pounds per acre in less favorable years. Of this, approximately 90 percent is from plants that furnish forage for cattle, sheep, and wildlife.

If this site is overgrazed, blueblunch wheatgrass, western wheatgrass, sand dropseed, skunkbush sumac, and curlleaf mountainmahogany decrease. Increasers on this site include prairie junegrass, Sandberg bluegrass, plains reedgrass, plains muhly, blue grama, perennial forbs, and woody species. Invaders are red three-awn, broom snakeweed, and annual forbs and grasses.

Because the soils in this site have steep rocky slopes, livestock tend to avoid the immediate site and concentrate their grazing on associated range sites.

If this site is heavily overgrazed and the range condition deteriorates, recovery is very slow. Range can be improved only through use of proper grazing and deferred rotation grazing. The very low available moisture capacity, steep and very steep slopes, and Rock outcrop restrict the use of mechanical range treatments and range seeding on the soils in this site.

STONY RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of very cobbly to stony loam. The subsoil is very cobbly to stony loam or clay loam. Slopes are 2 to 5 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderate. Available moisture capacity is low.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	55
Green needlegrass	10
Needleandthread	8
Western wheatgrass	7
Forbs	5
Idaho fescue	5
Sandberg bluegrass	5
Woody species	5
Plains reedgrass	trace
Prairie junegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,400 pounds per acre in

years of favorable moisture conditions and 850 pounds in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, bluebunch wheatgrass and green needlegrass decrease and western wheatgrass, needleandthread, plains reedgrass, prairie junegrass, Sandberg bluegrass, perennial forbs, and woody species increase. If overgrazing continues, cheatgrass, rabbitbrush, plains pricklypear, broom snakeweed, noxious weeds, and annual forbs and grasses invade the site.

This range site responds well to such management practices as proper grazing use and deferred rotation grazing. The high percentage of stones and cobbles in the surface layer restricts the use of mechanical treatments and range seeding on the soils in this site.

THIN BREAKS RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer and underlying material of sandy loam to clay. These soils formed in various kinds of geologic material and vary in depth over hard bedrock or soft shale. Slopes are mostly 9 to 35 percent, but some slopes range up to 70 percent. There are rock outcrops on steep slopes and ridgetops. The average annual precipitation is 10 to 14 inches.

Permeability is moderate. Available moisture capacity is very low to low.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	50
Needleandthread	10
Plains reedgrass	10
Conifers	5
Green needlegrass	5
Perennial forbs	5
Sedges	5
Western wheatgrass	5
Other woody species	5
Blue grama	trace
Bottlebrush squirreltail	trace
Prairie junegrass	trace
Sand dropseed	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 900 pounds per acre in years of favorable moisture conditions and 500 pounds per acre in less favorable years. Of this, approximately 90 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continuous heavy grazing, bluebunch wheatgrass, needleandthread, and green needlegrass decrease. Because of the wide variety of soil texture and depth in the soils in this site, a wide variety of plants increases under overgrazing. Some of the principal increasers are western wheatgrass, Sandberg bluegrass, prairie junegrass, plains reedgrass, sand dropseed, perennial forbs, and woody species. Invaders on this site are broom snakeweed, curlycup gumweed, needleleaf sedge, rabbitbrush, red threeawn, and annual forbs and grasses.

Areas of this range site are generally small and intermingled with other range sites. Range management practices consist mostly of proper grazing and deferred rotation grazing. Steep and very steep slopes, Rock outcrop, and the low available moisture capacity restrict the use of mechanical range treatment and range seeding.

SHALLOW RANGE SITE, 15- TO 19-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of gravelly loam. The underlying material is gravelly to very gravelly or stony loam. Bedrock is at a depth of 8 to 20 inches. Slopes are 9 to 60 percent. The average annual precipitation is 15 to 19 inches.

Permeability is moderate. Available moisture capacity is very low.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	40
Rough fescue	10
Idaho fescue	8
Big sagebrush	5
Conifers	5
Green and Columbia needlegrass	5
Needleandthread	5
Other woody species	5
Prairie junegrass	5
Western and thickspike wheatgrass	5
Forbs	3
Sedges	2
Timber danthonia	2
Sandberg bluegrass	trace
Shrubby cinquefoil	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable moisture conditions and 1,200 pounds per acre in less favorable years. Of this, approximately 90 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continuous heavy grazing, bluebunch wheatgrass, rough fescue, green needlegrass, and Columbia needlegrass decrease and are replaced by Idaho fescue, needleandthread, western and thickspike wheatgrass, prairie junegrass, Sandberg bluegrass, perennial forbs, and woody species. If overgrazing continues, the site is invaded by needleleaf sedge, broom snakeweed, rabbitbrush, annual grasses and forbs, timothy, smooth brome, and Kentucky bluegrass.

This range site generally responds well to such management practices as proper grazing use and deferred rotation grazing. The low available moisture capacity and steep and very steep slopes restrict the use of mechanical range treatments and range seeding on the soils in this site.

LIMY RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of silt loam or loam. The underlying material is silt loam to very cobbly loamy sand. In places these soils are gravelly, channery, or cobbly. Slopes are 0 to 35 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderately rapid to moderate. Available moisture capacity is mostly low to high.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	50
Needleandthread	15
Plains reedgrass	15
Western wheatgrass	10
Forbs	5

Species—continued	Percent
Plains muhly	5
Prairie junegrass	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,400 pounds per acre in years of favorable moisture conditions and 850 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

If this site is overgrazed, bluebunch wheatgrass decreases and needleandthread, Sandberg bluegrass, prairie junegrass, plains weedgrass, western wheatgrass, and forbs increase. If overgrazing is prolonged, the site is invaded by broom snakeweed, red three-awn, blue grama, curlycup gumweed, rabbitbrush, plains pricklypear, and annual grasses and forbs.

The soils of this range site are somewhat droughty and low in fertility. Response to such management practices as proper grazing use and deferred rotation grazing is slower than on the more fertile range sites.

SILTY RANGE SITE, 15- TO 19-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of silt loam or loam. The subsoil and underlying material are silt loam, loam, silty clay loam, or clay loam. In places these soils are gravelly, cobbly, or channery. Slopes are 2 to 35 percent. The average annual precipitation is 15 to 19 inches.

Permeability is moderate. Available moisture capacity is mostly low to high.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	Percent
Bluebunch wheatgrass	50
Green and Columbia needlegrass	15
Idaho fescue	10
Rough fescue	8
Forbs	5
Thickspike and western wheatgrass	5
Big sagebrush	3
Needleandthread	2
Other woody species	2
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,600 pounds per acre in years of favorable moisture condition and 1,800 pounds in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, such taller grasses as bluebunch wheatgrass, rough fesuce, green needlegrass, and Columbia needlegrass decrease and are replaced by Idaho fescue, western and thickspike wheatgrass, needleandthread, forbs, big sagebrush, and other woody species. If overgrazing continues, the site is invaded by cheatgrass, broom snakeweed, annual forbs and grasses, and such exotics as timothy, smooth brome, and Kentucky bluegrass.

This range site is highly productive. Where soils in this site are managed with steeper soils, the site is generally overgrazed and deteriorates in range condition. Areas large enough to justify fencing should be fenced off from other range sites to facilitate grazing management.

This range site generally responds well to such management practices as proper grazing use and deferred rotation grazing. Range condition improves rapidly, providing there is a good supply of the better grasses present to provide a source of seed for natural reseeding. Grass seedings are successful if a good seedbed is prepared and grazing is deferred until the seeded grass or grasses are established. Where brush is a problem, management measures are effective if there are enough climax grasses to provide a source of seeds.

SHALLOW RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of channery loam. The subsoil and underlying material are channery or very channery loam or sandy clay loam. These soils are mostly 8 to 18 inches deep over bedrock. Slopes are 10 to 35 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderate. Available moisture capacity is very low.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	Percent
Bluebunch wheatgrass	55
Threadleaf sedge	20
Needleandthread	10
Conifers	5
Forbs	5
Western wheatgrass	5
Blue grama	trace
Plains muhly	trace
Plains reedgrass	trace
Prairie junegrass	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,150 pounds per acre in years of favorable moisture conditions and 750 pounds in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under heavy grazing, bluebunch wheatgrass decreases and needleandthread, western wheatgrass, Sandberg bluegrass, threadleaf sedge, prairie junegrass, blue grama, and perennial forbs increase. If overgrazing continues, the site is invaded by needleleaf sedge, broom snakeweed, curlycup gumweed, and annual grasses and forbs.

The shallow soils in this range site are somewhat droughty, and range seeding on them is hazardous. Response to such management practices as proper grazing use and deferred rotation grazing is slower than on the range sites of deeper soils.

SHALLOW TO GRAVEL RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of somewhat excessively drained soils that have a surface layer of sandy loam or loam to very cobbly loam. The underlying material is sandy loam, loamy sand, or sand. In places these soils are gravelly, cobbly, or both. Slopes are 0 to 5 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderately rapid to rapid. Available moisture capacity is mostly very low.

The appropriate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	Percent
Bluebunch wheatgrass	55
Needleandthread	15
Western wheatgrass	15
Blue grama	5
Forbs	3
Sedges	3
Conifers	2
Sand dropseed	2
Prairie junegrass	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,150 pounds per acre in years of favorable moisture conditions and 750 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under heavy grazing, bluebunch wheatgrass, needleandthread, and western wheatgrass decrease and Sandberg bluegrass, prairie junegrass, blue grama, and perennial forbs increase. If overgrazing continues, broom snakeweed, curlycup gumweed, needleleaf sedge, red threeawn, plains pricklypear, and annual grasses and forbs invade the site.

The soils in this range site are droughty. Response to use of proper grazing and deferred rotation grazing is slower than on the range sites of deeper soils. Range seeding is hazardous on the droughty soils in this site.

SILTY RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of silt loam to clay loam. The subsoil and underlying material are silt loam, loam, clay loam, sandy loam, and loamy sand that in places is stratified. In places these soils are gravelly. Slopes are 0 to 25 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderate. Available moisture capacity is low to high.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	Percent
Bluebunch wheatgrass	55
Green needlegrass	10
Needleandthread	10
Forbs	5
Plains reedgrass	5
Silver sagebrush	5
Western wheatgrass	5
Other woody species	3
Sedges	2
Big sagebrush	trace
Blue grama	trace
Prairie junegrass	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable moisture conditions and 1,000 pounds in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, bluebunch wheatgrass and green needlegrass decrease and western wheatgrass, needleandthread, short grasses, sedges, forbs, sagebrush, and other woody plants increase. If overgrazing continues, cheatgrass, rabbitbrush, broom snakeweed, plains pricklypear, needleleaf sedge, annual grasses and forbs, and noxious weeds invade the site.

The range site is extensive in the survey area and is more productive than most other upland sites under similar moisture conditions. Because the soils are mostly gently sloping, the areas are easily accessible to grazing and are favored by livestock. Areas within easy reach of stock water tend to be overgrazed unless grazing is well managed. Where soils in the site are managed with steeper, less accessible soils, the site often deteriorates because livestock prefer to graze the gently sloping soils. Areas of this range site that are large enough to make fencing feasible should be fenced to facilitate grazing management.

This site generally responds well to such management practices as the use of proper grazing and deferred rotation grazing. Grass seeding is successful if a good seedbed is prepared and grazing is deferred until the new grass or grasses are well established. Where brush is a problem, management measures are quite effective if there are enough of the climax grasses to provide a source of seeds.

SANDY RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of sandy loam to cobbly sandy loam. The subsoil is loam to gravelly sandy loam, and the underlying material is loam to very gravelly loamy sand. Slopes are 1 to 35 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderately rapid to moderate. Available moisture capacity is low to high.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	Percent
Bluebunch wheatgrass	38
Needleandthread	15
Prairie sandreed	15
Forbs	5
Green needlegrass	5
Plains reedgrass	5
Silver sagebrush	5
Threadleaf sedge	5
Western wheatgrass	5
Sand dropseed	2
Other woody species	trace
Plains muhly	trace
Prairie junegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable moisture conditions and 1,000 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, bluebunch wheatgrass, prairie sandreed, and green needlegrass decrease and needleandthread, western wheatgrass, sand dropseed, threadleaf sedge, forbs, and woody plants increase. If heavy grazing continues, cheatgrass, needleleaf sedge, broom snakeweed, and annuals invade the site.

This range site generally responds well to such management practices as the use of proper grazing and deferred rotation grazing. Grass seeding is successful if a complete

seedbed is prepared and grazing is deferred until the new grass or grasses are well established. Brush management is feasible where brush is a problem if enough of the climax grasses are present to provide a source of seeds.

SANDS RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of loamy sand. The underlying material is loamy sand to very gravelly sandy loam or loamy sand. Slopes are 1 to 9 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderately rapid. Available moisture capacity is low to moderate.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Prairie sandreed	50
Needleandthread	20
Threadleaf sedge	15
Perennial forbs	5
Sand dropseed	5
Woody species	5
Prairie junegrass	trace
Western wheatgrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,000 pounds per acre in years of favorable moisture conditions and 1,200 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, prairie sandreed decreases and needleandthread, sand dropseed, western wheatgrass, threadleaf sedge, forbs, and woody species increase. If overgrazing continues, cheatgrass, needleleaf sedge, and annuals invade the site.

Most of the land in this range site in the survey area has been cultivated. It is highly susceptible to trampling and soil blowing if it is grazed too closely. Response is generally good to the use of proper grazing.

CLAYEY RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of well-drained soils that have a surface layer of clay loam to silty clay. The underlying materail is clay, silty clay loam, clay loam, or loam. Slopes are 0 to 20 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderately slow to slow. Available moisture capacity is mostly low to high.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Bluebunch wheatgrass	45
Green needlegrass	25
Western and thickspike wheatgrass	15
Big sagebrush	5
Forbs	5
Plains reedgrass	5
Other woody species	trace
Sandberg bluegrass	trace
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable moisture conditions and 1,000 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, bluebunch wheatgrass and green needlegrass decrease and are replaced by western wheatgrass, thickspike wheatgrass, plains reedgrass, Sandberg bluegrass, forbs, big sagebrush, and other woody species. If overgrazing continues, the site is invaded by broom snakeweed, curlycup gumweed, rabbitbrush, cheatgrass, plains pricklypear, annual forbs and grasses, and noxious weeds.

Soil compaction by livestock trampling is likely to occur on these clayey soils. Where the soils are compacted, the intake rate is reduced and water is lost through runoff.

Response to the use of proper grazing and deferred rotation grazing is good on the soils in this site.

OVERFLOW RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of moderately well drained to excessively drained soils that have a surface layer of loam to gravelly sandy loam. The underlying material is loam to very gravelly sand. Slopes are 0 to 5 percent. The average annual precipitation to 10 to 14 inches.

Permeability is moderate to rapid. Available moisture capacity is very low to moderate. These soils receive additional water from higher land areas. Some areas along streams are subject to annual overflow.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Basin wildrye	25
Western wheatgrass	20
Green needlegrass	15
Bluebunch wheatgrass	10
Other woody species	10
Forbs	8
Needleandthread	5
Sedges	5
Silver sagebrush	2
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 2,200 pounds per acre in years of favorable moisture conditions and 1,400 pounds per acre in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, such taller grasses as basin wildrye, green needlegrass, and bluebunch wheatgrass decrease and western wheatgrass, needleandthread, sedges, less palatable forbs, and silver sagebrush increase. Where this range site has been severely abused through overgrazing, foxtail barley, Kentucky bluegrass, needleleaf sedge, and annuals invade.

Vegetation stays green longer on this site than on other upland range sites. Livestock are attracted to these areas, and distribution of animals is a concern of management. Where it is feasible and practical to fence this range site separately, grazing intensity and season of use can be effectively controlled.

SALINE LOWLAND RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of moderately well drained to somewhat poorly drained soils that have a surface layer of

sandy loam to silty clay loam. The subsoil and underlying material are loam and sandy loam. Slopes are 0 to 5 percent. The average annual precipitation is 10 to 14 inches.

Permeability is moderate to slow. Available moisture capacity is low to high. A seasonal high water table is at a depth of 36 to 72 inches. Some areas are subject to overflow. The saline-alkali soils in this range site have concentrations of salts in the upper 12 inches.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Alkali sacaton	25
Greasewood	15
Western wheatgrass	15
Alkali cordgrass	10
Basin wildrye	10
Inland saltgrass	10
Alkaligrass	5
Sedges	5
Other woody species	3
Bottlebrush squirreltail	2
	100

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,600 pounds per acre in years of favorable moisture conditions and 1,800 pounds per acre in less favorable years. Of this, approximately 90 percent is from plants that furnish forage for cattle, sheep, and big game.

Under continued heavy grazing, alkali sacaton, basin wildrye, alkali cordgrass, and alkaligrass decrease and inland saltgrass, western wheatgrass, sedges, less palatable forbs, and greasewood increase. If overgrazing continues, foxtail barley, curlycup gumweed, and annuals invade the site.

This range site receives additional moisture from subirrigation and overflow. Plants stay green throughout the grazing season, and soils in this site are frequently abused through overgrazing. Where it is feasible and practical to fence this range site separately, grazing intensity and season of use can be effectively controlled.

SUBIRRIGATED RANGE SITE, 10- TO 14-INCH PRECIPITATION ZONE

This site consists of somewhat poorly drained to poorly drained soils that have a surface layer of loam, silt loam, silty clay loam, or silty clay. In places this layer is cobbly. The underlying material is clay, silty clay, silt loam, and cobbly loam. Slopes are 0 to 5 percent. The average annual precipitation is 10 to 19 inches.

Permeability is moderately slow to moderate. Available moisture capacity is low to high. A seasonal high water table is at a depth of 20 to 60 inches.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Prairie cordgrass	15
Tall reedgrass	15
Basin wildrye	10
Bearded, slender, and western wheatgrass	10
Meadow foxtail	10
Sedges	10
Tufted hairgrass	10
Forbs	8
Other woody species	8
Conifers	2
Mat muhly	2
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 5,000 pounds per acre in years of favorable moisture conditions and 3,500 pounds in less favorable years. Of this, approximately 85 percent is from plants that furnish forage for cattle and sheep. White-tailed deer and moose also frequent this site.

Under continued heavy grazing, the taller grasses and sedges decrease and wheatgrass, low sedges, unpalatable forbs, rosebush, and other woody plants increase. If overgrazing continues, Kentucky bluegrass, redtop, Baltic rush, iris, annuals, and unpalatable forbs invade the site.

This range site responds favorably to the use of proper grazing and deferred rotation grazing, except where it is dominated by Kentucky bluegrass, redtop, Baltic rush, iris, and low sedges. Mechanical improvement of the site is generally not feasible. Efficient grazing management is feasible for this site if it is fenced and grazed separately from adjacent upland sites.

WETLAND RANGE SITE, 10- TO 19-INCH PRECIPITATION ZONE

This site consists of poorly drained and very poorly drained soils that have a surface layer of sandy loam to clay. The underlying material is loamy sand to clay. Slopes range from 0 to 2 percent, but most slopes are less than 1 percent. The average annual precipitation is 10 to 19 inches.

Permeability is moderately rapid to slow. A seasonal high water table is within 0 to 20 inches of the surface during most of the growing season.

The approximate species composition, by air-dry weight, of the climax (potential) plant community is:

Species	*Percent*
Northern reedgrass	20
Sedges	19
Mannagrass	15
Prairie cordgrass	12
Reed canarygrass	10
Tufted hairgrass	8
Meadow foxtail	6
Forbs	5
Woody species	5
	100

If this site is in excellent condition, the average annual yield of air-dry herbage is about 6,500 pounds per acre in years of favorable moisture conditions and 5,000 pounds in less favorable years. Of this, approximately 95 percent is from plants that furnish forage for cattle and sheep. Moose and white-tailed deer also utilize this site.

Under continued heavy grazing, northern reedgrass, mannagrass, and prairie cordgrass decrease and tufted hairgrass, sedges, and unpalatable forbs increase. If overgrazing continues, Baltic rush, redtop, low sedges, iris, and other unpalatable forbs invade the site.

This range site generally responds well to proper grazing use and deferred rotation grazing. Response is poor where the plant cover is dominated by Baltic rush, redtop, iris, and sedges. This site is not suited to mechanical range treatment. Proper grazing use of this site is not feasible unless it is fenced separately from adjacent upland sites.

Use of the Soils for Windbreaks [4]

Tree windbreaks help reduce the impact of the wind on farms and ranches. They protect farmsteads against drifting snow and soil blowing. They also provide shelter for livestock and food and cover for birds and other wildlife.

The selection of trees and shrubs that grow best on a specific kind of soil insures survival and rapid growth. This selection is most important in dryland plantings. Proper soil preparation, moisture conservation, timely planting, and weed control are necessary for the successful establishment of a windbreak. Windbreaks provide maximum benefits when planted at right angles to the prevailing winds. They should be wide enough to protect the area that needs protection. Plantings on sandy soils normally need to be protected against soil blowing until the trees become established.

Windbreak suitability groups

Soil properties that are important in rating the suitability of a soil for windbreak plantings are the amount of and depth to lime in the soil profile, depth to bedrock, available moisture capacity, content of coarse rock fragments, permeability, degree of wetness, texture, annual precipitation, slope, and presence or absence of alkali and salt.

The soils of the survey area are placed in six windbreak suitability groups. The soils in each group have about the same degree of hazards and limitations for tree and shrub survival and development and need similar management for successful plantings. The group in which a soil is placed is identified by a number and a letter. The number expresses the degree of limitation or hazard, and the letter designates the determinant soil property. The degrees of limitation or hazards are indicated by the numeral *1* for slight, *2* for moderate, *3* for severe, and *4* for very severe. In this survey area, the soils have moderate to very severe limitations. Soils that have very severe limitations are not considered suitable for windbreak plantings. The determinant soil properties in the Broadwater County Area are designated by the letter *M* for available water capacity, *L* for depth to a concentrated lime zone, and *W* for depth to a permanent water table.

Each windbreak suitability group is described in the following paragraphs, and species of trees and shrubs most suited to the group are listed. To identify the windbreak suitability group in which each soil has been placed, refer to the "Guide to Mapping Units" at the back of this soil survey.

WINDBREAK SUITABILITY GROUP 2M

This group consists of moderately deep and deep, well drained and moderately well drained soils. These soils have a surface layer and underlying material of loamy sand to clay. Some soils have bedrock at a depth of 20 to 40 inches, and others have sandy gravel at a depth of 40 to 60 inches. Slopes range from 0 to 15 percent.

The available moisture capacity ranges from low to high but is mostly moderate. Permeability is moderately rapid to slow, and the average annual precipitation is 10 to 19 inches. Any concentrated lime zone is mostly below a depth of 24 inches.

Examples of tree and shrub species suitable for planting on irrigated soils in this group are caragana, honeysuckle, lilac, chokecherry, skunkbush sumac, purple willow, buffaloberry, sandcherry, cotoneaster, dogwood, Russian-olive, Siberian crabapple, green ash, Siberian elm, white willow, golden willow, cottonwood, ponderosa pine, Scotch pine, blue spruce, and Rocky Mountain juniper. Species suitable for planting on dryland soils include caragana, honeysuckle, lilac, chokecherry, skunkbush sumac, buffaloberry, sandcherry, Russian-olive, Siberian crabapple, green ash, Siberian elm, ponderosa pine, Scotch pine, blue spruce, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 2L

This group consists of deep, well-drained soils. These soils have a surface layer of loam and a subsoil of clay loam. In places the soils are cobbly. Slopes range from 2 to 9 percent.

The available moisture capacity is high. Permeability is moderate, and the average annual precipitation is 15 to 19 inches. A concentrated lime zone is at a depth of 15 to 24 inches.

Examples of tree and shrub species suitable for planting on irrigated soils in this group are caragana, honeysuckle, lilac, chokecherry, skunkbush sumac, buffaloberry, cotoneaster, Russian-olive, green ash, Siberian elm, ponderosa pine, Scotch pine, and Rocky Mountain juniper. Species suitable for planting on dryland soils in this group include caragana, honeysuckle, lilac, chokecherry, skunkbush sumac, buffaloberry, Russian-olive, green ash, Siberian elm, ponderosa pine, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 2W

This group consists of deep soils that have a seasonal or permanent high water table at a depth mostly between 30 and 60 inches. These soils have a surface layer and subsoil of sandy loam to silty clay. Some soils in this group are very cobbly and have sandy gravel at a depth of as little as 10 inches, but in most places the gravel is below a depth of 40 inches. Slopes range from 0 to 5 percent.

The available moisture capacity is low to high. Permeability is moderate and moderately slow, and the average annual precipitation is 10 to 14 inches. Any concentrated lime zone is at a depth of 15 inches or more.

Examples of tree and shrub species suitable for planting on irrigated or dryland soils in this group are honeysuckle, lilac, chokecherry, skunkbush sumac, purple willow, buffaloberry, sandcherry, cotoneaster, dogwood, Russian-olive, Siberian crabapple, green ash, Siberian elm, white willow, golden willow, cottonwood, ponderosa pine, Scotch pine, blue spruce, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 3M

This group consists of moderately deep and deep, well-drained soils. These soils have a surface layer and subsoil of loamy sand to silty clay. Some soils in this group are gravelly, cobbly, and very cobbly. In some soils depth to bedrock ranges from 20 to more than 60 inches, and in others depth to sandy gravel ranges from 36 to more than 60 inches. Slopes range from 1 to 20 percent.

[4] ASHLEY A. THORNBURG, plant material specialist, Soil Conservation Service, helped prepare this section.

The available moisture capacity is mostly low. Permeability is moderately rapid to slow, and the average annual precipitation is 10 to 19 inches. Any concentrated lime zone is at a depth of 15 inches or more.

Examples of tree and shrub species suitable for planting on irrigated soils in this group are caragana, honeysuckle, lilac, chokecherry, skunkbush, purple willow, buffaloberry, sandcherry, contoneaster, dogwood, Russian-olive, Siberian crabapple, green ash, Siberian elm, white willow, golden willow, cottonwood, ponderosa pine, blue spruce, and Rocky Mountain juniper. Species suitable for planting on dryland soils in this group include caragana, skunkbush sumac, buffaloberry, sandcherry, Russian-olive, Siberian crabapple, Siberian elm, ponderosa pine, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 3L

This group consists of deep, well-drained soils. These soils have a surface layer and subsoil of sandy loam to clay loam. In places, they are gravelly or cobbly. In some soils depth to bedrock is more than 60 inches, and on others depth to sandy gravel is 34 inches to more than 60 inches. Slopes range from 1 to 20 percent.

The available moisture capacity is low to high. Permeability is moderate, and the average annual precipitation is 10 to 14 inches. A concentrated lime layer is at a depth of less than 15 inches.

Examples of tree and shrub species suitable for planting on irrigated or dryland soils in this group are caragana, honeysuckle, lilac, skunkbush sumac, buffaloberry, Russian-olive, and Siberian elm.

WINDBREAK SUITABILITY GROUP 4

This group consists of all soils having slopes of more than 15 percent and of less sloping soils that have very severe soil limitations, as follows: soils that have very low available moisture capacity because of texture, depth, or a combination of these; rocky or stony soils; very poorly drained soils that have a water table at a depth of less than 10 inches for most of the growing season; heavy, dispersed clays; and strongly saline and alkali soils.

Soils in this group are not considered satisfactory for planting trees or shrubs.

Use of the Soils for Wildlife [5]

Wildlife is a product of the land. The abundance of a species is directly related to the extent and diversity of its habitat. The relationship of wildlife to soils is more aptly expressed as a soil-vegetation-wildlife relationship. Species of wildlife are more readily associated with the plant communities that make up their habitat than with specific soils alone. Productive, well-managed soils generally support or have potential to support vigorous wildlife populations, while infertile, poorly managed soils usually support sparse populations. Together, plants and animals constitute natural communities that are governed by many environmental influences, of which soil is but a part.

Range, coniferous forests, dryland and irrigated cropland, riparian woodlands, streams and rivers, and ponds and reservoirs provide a variety of wildlife habitat in the Broadwater County Area.

Irrigated and dryland farming has made possible the successful introduction of the ring-necked pheasant and the gray partridge, particularly in the bottom lands along the Missouri River and adjacent to Canyon Ferry Reservoir. This was possible because of varied land use patterns that include small grains, irrigated crops, and annual weeds plus adequate cover. The pheasant population is limited by the very farming practices that fostered it. In recent years more intensive "clean" farming and the loss of brushy fencerows, densely vegetated ditchbanks, and fewer odd-shaped areas have coincided with a decline in the number of pheasants.

Management practices beneficial to pheasants include proper grazing, protection of woody cover, and leaving crop residue and fencerows protected from burning or grazing. Woody plantings, in the form of shelterbelts and hedgerows, on cropland for control of erosion are also beneficial to pheasants as well as to numerous nongame birds.

Gray, or Hungarian, partridge also are associated with crop and grassland areas of the survey area. Populations of gray partridge have fluctuated, building to fair numbers and then declining because of weather, disease, or changes in habitat.

Sharptail grouse occur throughout much of the prairie uplands of the survey area, where grainfields, brushy cover, and an abundance of fruit-bearing shrubs, including cherry, rose, snowberry, sumac, and buffaloberry, provide excellent habitat. Within limits, sharptails adapt to modern farming. During winter they readily feed on grain in stubble, in stocks, and in cattle feedlots. During dry periods in July or August, they may collect in large shelterbelts where water and shade are available.

Populations of sharptail grouse vary greatly between the dry sagebrush country and the more moist upland prairies. When populations are high, breeding sharptails extend their range well into marginal islands of native grassland, usually along drainageways surrounded by wheat, barley, or summer fallow. Conversely, when populations are low, they are more restricted around the upper limits of drainageways, where the best stands of intermixed tree-shrub grasslands grow.

Sage grouse in the Broadwater County Area inhabit areas of range that have a cover of sagebrush. The sage grouse depends for its existence on sagebrush range in good vegetative condition and is tolerant of man and livestock, provided its habitat requirements are met.

Management practices beneficial to sharptails and sage grouse include proper grazing to insure that sufficient vegetation remains for nesting, roosting, and rearing of young and the protection of woody vegetation in draws and along fencerows, which provide both food and shelter.

Three species of forest-dwelling grouse—blue, spruce, and ruffed grouse—are common in the coniferous forested areas of the survey area, especially in the Big Belt Mountains. A variety of habitats is important to forest grouse at different seasons of the year.

Blue grouse winter at high elevations, and early in spring they descend to semiopen timber for breeding and brood rearing. Ruffed grouse inhabit a denser cover of mixed conifers and deciduous trees and brush and are often found

[5] By RONALD F. BATCHELOR, biologist, Soil Conservation Service.

along stream bottoms. Adult ruffed grouse may spend most of their lives in less than 2 square miles of habitat. Spruce grouse inhabit the dense forest types, such as subalpine fir, Englemann spruce, and lodgepole pine.

Forest grouse habitat depends greatly upon the stages of forest growth and effects of logging, grazing, and fires. The amount and quality of grouse habitat in the future will be determined mainly by forest management.

Merriam's turkeys have been relocated in the northeastern part of the Broadwater County Area. Suitable habitat is generally restricted to open ponderosa pine forests in rugged terrain. Turkeys have been most successful in forests where the vegetative cover consists of ponderosa pine and grasses, deciduous trees, and shrubs in scattered small openings and drainageways throughout the forest.

Pronghorn antelope in the survey area occupy range along with domestic livestock. The potential for maintaining antelope herds is dependent on the proper management of the range. Competition for food between livestock and antelope is not serious on well-managed range and is seldom a concern in the survey area. Antelope utilize forbs and browse species that cattle do not commonly eat.

Both white-tailed and mule deer occur throughout the survey area. White-tails most generally inhabit lowlands, the valleys and islands of the Missouri and Jefferson Rivers, brushy bottoms, and lower foothills adjacent to farmland. Mule deer occur throughout the Big Belt and Elkhorn Mountains and along the breaks, brushy bottoms, and timbered slopes of the western part of the survey area.

Rocky Mountain elk are widely distributed throughout the Big Belt and Elkhorn Mountains. Their habitat is classified as browse range and grass range on the basis of winter food. Elk prefer range of native bunchgrass, but they are adaptable and will feed on other grasses, sedges, forbs, and browse.

Canyon Ferry Reservoir and numerous ponds provide habitat for waterfowl during spring and fall migrations. Ducks and geese use these bodies of water for resting, and they fly to nearby fields to feed on waste grains.

Beaver, mink, otter, and muskrat occur throughout the major watercourses, while cottontail rabbits, badger, ground squirrels, coyotes, bobcats, and other small mammals can be found throughout the survey area.

Populations of game as well as nongame species could be enhanced through application of conservation practices that improve habitat. Among these are development of oddly or irregularly shaped areas in and adjacent to farmland, protection of such areas from fire or grazing, and the establishment of woody vegetation that provides winter cover. Wildlife may also be enhanced through increased application of commonly employed conservation practices, including proper grazing use, planned grazing systems, stripcropping, field windbreaks, and the construction of ponds.

Sport fishing for rainbow, brown, and brook trout is provided by the Missouri and Jefferson Rivers and a number of smaller streams, including Deep, Dry, Crow, and Beaver Creeks. Brown trout are common in the Missouri and Jefferson Rivers, and rainbow and brook trout are abundant in the smaller streams. Canyon Ferry Reservoir offers a variety of fishing opportunities, from smallmouth bass to rainbow trout. Numerous farm ponds scattered throughout the county offer a wealth of recreational fishing.

Field offices of the Soil Conservation Service maintain specific habitat management guides for each important species of wildlife and for each significant plant that provides food or cover for wildlife. They also have specifications for the establishment and maintenance of each conservation practice that is adaptable to the soils and waters in the survey area. Thus, any landowner can obtain practical help in planning and establishing food supply and habitat for the kinds of wildlife he wishes to favor.

Use of the Soils for Recreation

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 3 the soils of the Broadwater County Area are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 3 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and that limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

TABLE 3.—*Limitations of the soils for selected recreational uses*

Soil series	Camp areas	Picnic areas	Playgrounds	Paths and trails
Abor: AbC	Severe: clayey	Severe: clayey	Severe: clayey; slopes are 6 to 9 percent.	Severe: clayey.
Aeric Fluvaquents: Af. Too variable to be rated. Onsite investigations needed.				
Amesha: AmB, AmC, AnB, AoB, AoC.	Slight for all but AnB if slopes are 1 to 8 percent, moderate if 8 to 9 percent. Moderate for AnB: cobbles cover 20 to 50 percent of surface.	Slight for all but AnB if slopes are 1 to 8 percent, moderate if 8 to 9 percent. Moderate for AnB: cobbles cover 20 to 50 percent of surface.	Slight for all but AnB if slopes are 1 to 2 percent, moderate if 2 to 6 percent, severe if 6 to 9 percent. Severe for AnB: cobbles cover 20 to 50 percent of surface.	Slight for all but AnB. Moderate for AnB: cobbles cover 20 to 50 percent of surface.
Blaine: BcE. For Cheadle part, see Cheadle series.	Moderate if slopes are 10 to 15 percent; severe if 15 to 25 percent, cobbles cover 20 to 50 percent of surface.	Moderate if slopes are 10 to 15 percent; severe if 15 to 25 percent, cobbles cover 20 to 50 percent of surface.	Severe: slopes are 10 to 25 percent; cobbles cover 20 to 50 percent of surface.	Moderate: cobbles cover 20 to 50 percent of surface; slopes are 10 to 25 percent.
Blanyon: BdC	Moderate: clay loam; slopes are 8 to 10 percent; permeability is 0.20 to 0.60 inch per hour.	Moderate: clay loam; slopes are 8 to 10 percent.	Moderate if slopes are 3 to 6 percent; severe if 6 to 10 percent, clay loam surface layer.	Moderate: clay loam surface layer.
Borohemists: Bo	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.
Bridger: BpD, BrD	Slight for BrD if slopes are 5 to 8 percent; moderate if 8 to 15 percent. Moderate for BpD: cobbles cover 20 to 50 percent of surface.	Slight for BrD if slopes are 5 to 8 percent; moderate if 8 to 15 percent. Moderate for BpD: cobbles cover 20 to 50 percent of surface.	Moderate for BrD if slopes are 5 to 6 percent; severe if 6 to 15 percent. Severe for BpD: cobbles cover 20 to 50 percent of surface.	Slight for BrD. Moderate for BpD: cobbles cover 20 to 50 percent of surface.
Brocko: BsA, BsB, BsC, BsD, BtA.	Slight if slopes are 0 to 8 percent; moderate if 8 to 15 percent; severe if 15 to 25 percent.	Slight if slopes are 0 to 8 percent; moderate if 8 to 15 percent; severe if 15 to 25 percent.	Slight if slopes are 0 to 2 percent; moderate if 2 to 6 percent; severe if 6 to 25 percent.	Slight if slopes are 0 to 15 percent; moderate if 15 to 25 percent.
Cabbart: CaE	Moderate if slopes are 9 to 15 percent; severe if 15 to 35 percent, clay loam surface layer.	Moderate if slopes are 9 to 15 percent; severe if 15 to 35 percent, clay loam surface layer.	Severe: slopes are 9 to 35 percent; bedrock at a depth of less than 20 inches.	Moderate if slopes are 15 to 25 percent; severe if 25 to 35 percent; clay loam surface layer.
Cheadle: CdE	Severe: 50 percent or more surface stones, channers, or both; slopes are more than 15 percent.	Severe: 50 percent or more surface stones, channers, or both; slopes are more than 15 percent.	Severe: bedrock at a depth of less than 20 inches; more than 20 percent stones, channers, or both; slopes are more than 6 percent.	Severe: 50 percent or more surface stones, channers, or both; slopes are more than 25 percent.
Chinook: ChB, ChC, CmC, CnC, CnE. For Crago part of CmC, CnC, and CnE, see Crago series.	Slight for all but CmC, CnC, and CnE if slopes are 1 to 8 percent; moderate if 8 to 15 percent; severe if more than 15 percent. Moderate for CmC: loamy sand surface layer. Moderate for CnC: cobbles cover 20 to 50 percent of surface. Moderate for CnE if slopes are 9 to 15 percent, cobbles cover 20 to 50 percent of surface.	Slight for all but CmC, CnC, and CnE if slopes are 1 to 8 percent; moderate if 8 to 15 percent; severe if more than 15 percent. Moderate for CmC: loamy sand surface layer. Moderate for CnC: cobbles cover 20 to 50 percent of surface. Moderate for CnE if slopes are 9 to 15 percent, cobbles cover 20 to 50 percent of surface.	Slight for all but CmC and and CnE if slopes are 1 to 2 percent; moderate if 2 to 6 percent; severe if more than 6 percent. Moderate for CmC: loamy sand surface layer. Severe for CnC: cobbles cover 20 to 50 percent of surface.	Slight for all but CmC, CnC, and CnE if slopes are 1 to 15 percent; moderate if 15 to 25 percent; severe if more than 25 percent. Moderate for CmC: loamy sand surface layer. Moderate for CnC: cobbles cover 20 to 50 percent of surface. Moderate for CnE if slopes are 15 to 25 percent, cobbles cover 20 to 50 percent of surface.
Chinook variant: CkB	Slight	Slight	Slight if slopes are 1 to 2 percent, moderate if 2 to 4 percent.	Slight.
Crago: CrC	Moderate: cobbles cover 20 to 50 percent of surface.	Moderate: cobbles cover 20 to 50 percent of surface.	Severe: cobbles cover more than 20 percent of surface; slopes are 6 to 9 percent.	Moderate: cobbles cover 20 to 50 percent of surface.
Delphill: DeB, DhD. For Abor part of DhD, see Abor series.	Slight if slopes are 2 to 8 percent, moderate if 8 to 15 percent; severe if more than 15 percent.	Slight if slopes are 2 to 8 percent; moderate if 8 to 15 percent; severe if more than 15 percent.	Moderate if slopes are 2 to 6 percent; severe if more than 6 percent.	Slight if slopes are 2 to 15 percent; moderate if 15 to 20 percent.

TABLE 3.—*Limitations of the soils for selected recreational uses*—Continued

Soil series	Camp areas	Picnic areas	Playgrounds	Paths and trails
Dominic: Do	Moderate where cobbles cover 20 to 50 percent of surface, some areas flood occasionally. Severe where cobbles cover more than 50 percent.	Moderate where cobbles cover 20 to 50 percent of surface, some areas flood occasionally. Severe where cobbles cover more than 50 percent.	Moderate: some areas flood occasionally. Severe where cobbles cover more than 20 percent of surface.	Moderate where cobbles cover 20 to 50 percent of surface. Severe where more than 50 percent.
Ess: EcF For Cheadle part, see Cheadle series.	Severe: slopes are 35 to 60 percent; stones cover more than 15 percent of surface.	Severe: slopes are 35 to 60 percent; stones cover more than 15 percent of surface.	Severe: slopes are 35 to 60 percent; stones cover more than 15 percent of surface.	Severe: slopes are 35 to 60 percent; stones cover more than 15 percent of surface.
Fairdale: Fa, Fb For Lothair part of Fb, see Lothair series.	Slight for Fa. Severe for Fb: silty clay surface layer.	Slight for Fa. Severe for Fb: silty clay surface layer.	Slight for Fa. Severe for Fb: silty clay surface layer.	Slight for Fa. Severe for Fb: silty clay surface layer.
Fluvaquentic Haplaquolls: Fd	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.
Havre: Ha	Slight	Slight	Slight	Slight.
Hilger: HgE	Severe: stones cover 25 percent or more of surface; slopes are more than 15 percent in places.	Severe: stones cover 25 percent or more of surface; slopes are more than 15 percent in places.	Severe: stones cover 25 percent or more of surface; slopes are more than 8 percent.	Severe: stones cover 25 percent or more of surface.
Lake Creek: LaF	Severe: slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent.	Moderate if slopes are 20 to 25 percent; severe if more than 25 percent.
Loberg: LoE	Moderate where slopes are 10 to 15 percent; severe where more than 15 percent, stones cover 10 to 25 percent of surface.	Moderate where slopes are 10 to 15 percent; severe where more than 15 percent, stones cover 10 to 25 percent of surface.	Severe: slopes are more than 10 percent; stones cover 10 to 25 percent of surface.	Moderate where slopes are 15 to 25 percent, stones cover 10 to 25 percent of surface. Severe where slopes are more than 25 percent.
Lothair: Lt	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.
Martinsdale: MaB, MaC, McC	Slight if slopes are 2 to 8 percent. Moderate for McC if slopes are 8 to 9 percent; cobbles cover 20 to 50 percent of surface.	Slight if slopes are 2 to 8 percent. Moderate for McC if slopes are 8 to 9 percent; cobbles cover 20 to 50 percent of surface.	Moderate if slopes are 2 to 6 percent. Severe for McC if slopes are more than 6 percent; cobbles cover 20 to 50 percent of surface.	Slight for all but McC. Moderate for McC: cobbles cover 20 to 50 percent of surface.
Mine dumps: Md	Severe: rough topography.	Severe: rough topography.	Severe: rough topography.	Severe: rough topography.
Mussel: MsA, MsB, Mt, MuB, MuC. For Crago part of Mt, see Crago series; for Musselshell part of MuB and MuC, see Musselshell series.	Slight if slopes are 0 to 8 percent, moderate if 8 to 9 percent.	Slight if slopes are 0 to 8 percent, moderate if 8 to 9 percent.	Slight if slopes are 0 to 2 percent; moderate if 2 to 6 percent; severe if more than 6 percent.	Slight.
Musselshell: MvB, MvC, MwE, MxE, MyC. For Thess part of MyC, see Thess series; for Crago part of MwE and MxE, see Crago series.	Moderate if slopes are 8 to 15 percent; gravel, cobbles, or channers cover 20 to 50 percent of surface. Severe if slopes are more than 15 percent.	Moderate if slopes are 8 to 15 percent; gravel, cobbles, or channers cover 20 to 50 percent of surface. Severe if slopes are more than 15 percent.	Severe: slopes are more than 6 percent: gravel, cobbles, or channers cover more than 20 percent of surface.	Moderate if slopes are 15 to 25 percent; gravel, cobbles, or channers cover 20 to 50 percent of surface. Severe if slopes are more than 25 percent.
Nielsen: NeF	Severe: slopes are 15 to 60 percent.	Severe: slopes are 15 to 60 percent.	Severe: slopes are 15 to 60 percent; bedrock at a depth of less than 20 inches.	Moderate if slopes are 15 to 25 percent, severe if more than 25 percent.
Passcreek: PaD, PcE For Lake Creek part of of PcE, see Lake Creek series.	Moderate if slopes are 8 to 15 percent; channers cover 20 to 50 percent of surface; severe if slopes are more than 15 percent.	Moderate if slopes are 8 to 15 percent; channers cover 20 to 50 percent of surface; severe if slopes are more than 15 percent.	Severe: slopes are more than 6 percent; channers cover more than 20 percent of surface.	Slight if slopes are 6 to 15 percent, moderate if 15 to 25 percent; channers cover 20 to 50 percent of surface; severe if slopes are more than 25 percent.
Perma: Pm, Pr	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.

TABLE 3.—*Limitations of the soils for selected recreational uses*—Continued

Soil series	Camp areas	Picnic areas	Playgrounds	Paths and trails
Radersburg: Ra	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.	Severe: cobbles cover more than 50 percent of surface.
Rencot: ReE	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Moderate if slopes are 15 to 25 percent, severe if more than 25 percent.
Rivra: Rr	Moderate: flooding hazard; 20 to 50 percent gravel.	Moderate: flooding hazard; 20 to 50 percent gravel.	Severe: more than 20 percent gravel.	Moderate: 20 to 50 percent gravel.
Rooset: RsE	Severe: stones cover 25 percent or more of surface.	Severe: stones cover 25 percent or more of surface.	Severe: stones cover 25 percent or more of surface.	Severe: stones cover 25 percent or more of surface.
Rootel: RtC	Slight if slopes are 3 to 8 percent, moderate if 8 to 9 percent.	Slight if slopes are 3 to 8 percent, moderate if 8 to to 9 percent.	Moderate if slopes are 3 to 6 percent, channers cover 10 percent of surface; severe if slopes are more than 6 percent.	Slight.
Sappington: SaB, SaC, SgB, SgC.	Slight if slopes are 2 to 8 percent. Moderate for SgB and SgC if slopes are 8 to 9 percent; gravel covers 20 to 50 percent of surface.	Slight if slopes are 2 to 8 percent. Moderate for SgB and SgC if slopes are 8 to 9 percent; gravel covers 20 to 50 percent of surface.	Moderate if slopes are 2 to 6 percent. Severe for SgB and SgC if slopes are more than 6 percent; 20 to 50 percent gravel.	Slight for all but SgB and SgC. Moderate for SgB and SgC: 20 to 50 percent gravel.
Scravo: Sv, Sw	Moderate where cobbles cover 20 to 50 percent of surface; severe where more than 50 percent.	Moderate where cobbles cover 20 to 50 percent of surface; severe where more than 50 percent.	Severe where cobbles cover more than 20 percent of surface.	Moderate where cobbles cover 20 to 50 percent of surface; severe where more than 50 percent.
Thess: Te, Ts For Scravo part of Ts, see Scravo series.	Slight	Slight	Slight if slopes are 0 to 2 percent; moderate if 2 to 3 percent.	Slight.
Tolman: TtE	Moderate if slopes are 10 to 15 percent; channers cover 20 to 50 percent of surface. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 10 to 15 percent; channers cover 20 to 50 percent of surface. Severe if slopes are 15 to 35 percent.	Severe: slopes are more than 10 percent; channers cover 20 to 50 percent of surface; bedrock at a depth of less than 20 inches.	Moderate if slopes are 15 to 25 percent; channers cover 20 to 50 percent of surface. Severe if slopes are 25 to 35 percent.
Toston: Tu	Moderate: silty clay loam; permeability is 0.06 to 0.20 inch per hour.	Moderate: silty clay loam.	Moderate: silty clay loam; permeability is 0.06 to 0.20 inch per hour.	Moderate: silty clay loam.
Tropal: TvF	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent; gravel or stones cover 20 to 50 percent of surface.	Moderate if slopes are 15 to 25 percent; gravel or stones cover 20 to 50 percent of surface. Severe if slopes are more than 25 percent.
Ustic Torrifluvents: Uf	Moderate: flooding hazard.	Moderate: flooding hazard.	Severe: flooding hazard	Moderate: flooding hazard.
Ustic Torriorthents, saline: Ut.	Moderate: surface texture variable.	Moderate: surface texture variable.	Moderate: surface texture variable; slopes are 2 to 5 percent.	Moderate: surface texture variable.
Villy: Va, Vd	Moderate for Vd: silty clay loam surface layer; permeability is 0.20 to 0.60 inch per hour. Severe for Va: water table at a depth of less than 20 inches.	Moderate for Vd: silty clay loam surface layer. Severe for Va: water table at a depth of less than 20 inches.	Moderate for Vd: silty clay loam surface layer; permeability is 0.20 to 0.60 inch per hour. Severe for Va: water table at a depth of less than 20 inches.	Moderate for Vd: silty clay loam surface layer. Severe for Va: water table at a depth of less than 20 inches.
Whitore: WhF	Severe: slopes are more than 25 percent.	Severe: slopes are more than 25 percent.	Severe: slopes are more than 25 percent.	Severe: slopes are more than 25 percent.
Windham: WnE	Moderate if slopes are 9 to 15 percent; cobbles cover 20 to 50 percent of surface. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 9 to 15 percent; cobbles cover 20 to 50 percent of surface. Severe if slopes are 15 to 35 percent.	Severe: slopes are more than 9 percent.	Moderate if slopes are 15 to 25 percent; cobbles cover 20 to 50 percent of surface. Severe if slopes are more than 25 percent.
Woodrock: WoF, WrE For Loberg part of WoF, see Loberg series.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Moderate if slopes are 15 to 25 percent, severe if more than 25 percent.

Engineering Uses of the Soil [6]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect the construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Make soil and land-use studies that aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in the planning of farm drainage systems, farm ponds, irrigation systems, terraces, waterways, and spreader dikes.
3. Make preliminary evaluations of soil and ground conditions that aid in selecting locations of highways, roads, and airports and in planning detailed investigations at the selected locations.
4. Locate probable sources of gravel, sand, or other construction material.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that is useful in designing and maintaining the structures.
6. Determine the suitability of soils to withstand cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used more readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to a particular area.

Most of the information in this section is presented in tables 4 and 5, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses of the soils. This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists but are not known to all engineers. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by the Soil Conservation Service, Department of Defense,[7] and other agencies, and the AASHTO system,[8] adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups that range from A–1 to A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

Estimated soil properties significant in engineering

Several estimated soil properties significant in engineering are shown in table 4. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 4.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

[6] IRVING J. NELSON, engineer, Soil Conservation Service, helped prepare this section.

[7] American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

[8] American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account the relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand."

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts. Rates are defined in the Glossary.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Potential frost action refers to the probable effects on structure that result from the freezing of soil material and its subsequent thawing. These probable effects are important factors in selecting sites for highways or for any structure that is supported or abutted by soil that freezes. The action pertains not only to the heaving of the soil as freezing progresses, but also to the excessive wetting and loss of soil strength during thawing. Soils that have properties that are not susceptible to frost action are rated *low*; soils whose properties make them moderately susceptible to frost action are rated *moderate*; and soils that have properties that make them highly susceptible to frost action are rated *high*.

Corrosivity, as used in table 4, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations made entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of soils

The interpretations in table 5 are based on the estimates of engineering properties of the soils shown in table 4, on test data for soils in nearby or adjoining areas, and on the experience of engineers and soil scientists with the soils of the Broadwater County Area. In table 5 ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for agricultural drainage, irrigation, farm pond reservoirs and embankments, and terraces, waterways, and diversions. For these particular uses, table 5 lists soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Sand and gravel is used in great quantities in many kinds of construction. The ratings in table 5 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account location of the water table or other factors that affect mining of the materials, and neither do they indicate the quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Farm pond reservoirs hold water behind a dam or embankment. Soils suitable for farm pond reservoirs have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Farm pond embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Pres-

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping that appear in the first column of this table. The

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal water table			Unified	AASHTO	
	Inches	*Feet*	*Inches*				
Abor: AbC	20–40	>10	0–38 38–60	Silty clay or clay Clay shale.	CL or CH	A–7	0
Aeric Fluvaquents: Af. Too variable to be estimated.							
Amesha: AmB, AmC, AnB, AoB, AoC.	>60	>10	0–60	Loam	ML or CL-ML	A–4	0
*Blaine: BcE For Cheadle part, see Cheadle series.	20–40	>10	0–24 24	Gravelly or very gravelly loam or clay loam. Igneous bedrock.	GM or GC	A–2	25–45
Blanyon: BdC	>60	>10	0–60	Clay loam	CL	A–6	0
Borohemists: Bo. Too variable to be estimated.							
Bridger: BpD, BrD	>60	>10	0–60	Gravelly or channery clay loam.	GC	A–6	10–30
Brocko: BsA, BsB, BsC, BsD, BtA	>60	3–>10	0–60	Silt loam	ML	A–4	0
Cabbart: CaE	10–20	>10	0–15 15–60	Clay loam or loam Soft siltstone or sandstone.	CL or ML	A–6 or A–4	0
Cheadle: CdE	7–20	>10	0–8 8	Stony loam Igneous bedrock or argillite.	GM	A–1	25–35
*Chinook: ChB, ChC, CmC, CnC, CnE. For Crago part of CmC, CnC, and CnE, see Crago series.	>60	>10	0–14 14–60	Sandy loam Gravelly sandy loam	SM SM	A–2 or A–4 A–1	0–10 10–20
Chinook variant: CkB	>60	>6	0–23 23–60	Sandy loam Very gravelly loamy sand	SM GW–GM	A–2 or A–4 A–1	0–5 5–10
Crago: CrC	>60	>10	0–36 36–60	Gravelly or cobbly loam Very gravelly loamy sand	GM GW–GM	A–2 or A–4 A–1	15–25 25–35
*Delphill: DeB, DhD For Abor part of DhD, see Abor series.	20–40	>10	0–35 35–60	Loam or clay loam Soft siltstone.	ML or CL	A–6 or A–4	0
Dominic: Do	>60	5–10	0–60	Very cobbly or very gravelly sandy loam or loamy sand.	GW–GM	A–1	40–60
*Ess: EcF For Cheadle part, see Cheadle series.	40–>60	>10	0–60	Stony or very stony loam or clay loam.	GM	A–1, A–2, or A–4	50–70
*Fairdale: Fa, Fb For Lothair part of Fb, see Lothair series.	>60	3–5	0–60	Loam or silt loam	ML or CL	A–4	0
Fluvaquentic Haplaquolls: Fd. Too variable to be estimated.							
Havre: Ha	>60	4–>6	0–60	Loam	ML	A–4	0
Hilger: HgE	>60	>10	0–60	Very stony clay loam	GC	A–4	50–65
Lake Creek: LaF	20–40	>10	0–35 35	Channery loam Hard argillite bedrock.	GM	A–2	10–30
Loberg: LoE	>60	>10	0–23 23–60	Channery clay loam and channery clay. Very channery silt loam and very channery silty clay loam.	GC GM or ML	A–6 A–1, A–2, or A–4	25–40 30–45
Lothair: Lt	>60	>6	0–60	Silty clay	CL or CH	A–6 or A–7	0
Martinsdale: MaB, MaC, McC	>60	>10	0–60	Loam or channery loam	SM or ML	A–4	0–5
Mine dumps: Md. Too variable to be estimated.							

See footnotes at end of table.

significant to engineering

units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series symbol > means more than; the symbol < means less than]

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Potential frost action	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Untreated steel	Concrete
				Inches per hour	*Inches per inch of soil*	*pH*				
95-100	90-100	80-100	75-95	0.06-0.2	0.12-0.16	7.4-7.8	High	Moderate	High	Low.
90-100	90-100	60-95	50-70	0.6-2.0	0.14-0.20	7.9-8.4	Low	High	High	Low.
55-65	35-50	30-40	25-35	0.6-2.0	0.07-0.11	7.4-8.4	Low	Moderate	High	Low.
95-100	85-100	75-100	70-80	0.2-0.6	0.15-0.19	7.8-8.4	Moderate	High	High	Low.
60-80	50-75	45-70	35-60	0.6-2.0	0.11-0.15	7.4-8.4	Moderate	Moderate	High	Low.
100	100	85-100	75-90	0.6-2.0	0.18-0.22	7.9-8.4	Low	High	High	Low.
95-100	95-100	80-95	60-75	0.6-2.0	0.16-0.20	7.9-8.4	Moderate	High	High	Low.
40-45	30-35	25-30	15-25	0.6-2.0	0.04-0.08	6.6-7.3	Low	Moderate	High	Low.
90-100	90-95	60-70	30-40	2.0-6.0	0.10-0.14	7.4-8.4	Low	Moderate	High	Low.
65-75	55-65	35-45	20-25	2.0-6.0	0.08-0.10	7.8-8.4	Low	Moderate	High	Low.
90-100	90-100	60-70	30-40	2.0-6.0	0.10-0.14	7.4-8.4	Low	Moderate	High	Low.
40-50	20-35	10-25	5-10	6.0-20.0	< 0.05	7.4-7.8	Low	Low or moderate.	High	Low.
55-65	45-50	30-40	25-40	0.2-0.6	0.06-0.10	7.9-8.4	Low	Moderate	High	Low.
50-55	25-35	15-35	5-10	6.0-20.0	0.02-0.06	7.4-8.4	Low	Low	High	Low.
95-100	95-100	85-100	60-80	0.6-2.0	0.16-0.20	7.9-8.6	Moderate	High	High	Low.
50-55	30-40	10-20	5-10	6.0-20.0	0.02-0.06	7.4-7.8	Low	Low	High	Low.
30-70	30-65	25-60	20-50	0.6-2.0	0.05-0.10	6.6-7.3	Low	Low	High	Low.
100	95-100	85-100	60-90	0.6-2.0	0.16-0.20	7.4-7.8	Low	High	High	Low.
100	95-100	85-95	60-80	0.6-2.0	0.15-0.20	7.4-7.8	Low	High	High	Low.
60-70	55-65	45-55	40-50	0.6-2.0	0.07-0.12	7.4-8.4	Low	Moderate	High	Low.
50-60	40-55	30-55	25-35	0.6-2.0	0.07-0.11	6.6-7.3	Low	Moderate	High	Low.
60-80	50-70	45-65	35-50	0.06-0.20	0.09-0.14	6.6-7.3	Low	Moderate	High	Low.
40-75	35-70	30-65	25-60	0.6-2.0	0.05-0.10	7.4-8.4	Low	Moderate	High	Low.
100	100	95-100	90-95	0.06-0.20	0.12-0.16	8.2-8.4	Moderate	Moderate	High	Low.
70-100	55-100	50-95	35-75	0.6-2.0	0.15-0.20	7.9-8.4	Low	High	High	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal water table			Unified	AASHTO	
	Inches	*Feet*	*Inches*				
*Musselshell: MsA, MsB, Mt, MuB, MuC. For Crago part of Mt, see Crago series; for Musselshell part of MuB and MuC, see Musselshell series.	>60	>10	0-60	Loam or gravelly loam	SM or ML	A-4	0
*Musselshell: MvB, MvC, MwE, MxE, MyC. For Crago part of MwE and MxE, see Crago series; for Thess part of MyC, see Thess series.	>60	>10	0-43	Cobbly, channery, or gravelly loam.	SM or CL-ML	A-4	10-40
			43-60	Very gravelly loamy sand or cobbly or gravelly loamy sand.	GW-GM or GM	A-1	25-50
Nielsen: NeF	10-20	>10	0-14	Very channery or channery loam.	GM	A-1, A-2, or A-4	5
			14	Argillite bedrock.			
*Passcreek: PaD, PcE For Lake Creek part of PcE, see Lake Creek series.	20-40	>10	0-38	Channery silt loam and channery silty clay loam.	GM or ML	A-2 or A-4	0
			38	Argillite bedrock.			
Perma: Pm, Pr	>60	[2] 3->6	0-43	Very cobbly or very gravelly loam and sandy loam.	GM-GC or GM	A-1 or A-2	15-30
			43-60	Very cobbly sand	GW	A-1	65-70
Radersburg: Ra	>60	>6	0-60	Cobbly loam	GM	A-4	40-50
Rencot: ReE	10-20	>10	0-18	Channery loam or very channery loam.	GM	A-1, A-2, or A-4	0-10
			18	Fractured argillite.			
Rivra: Rr	>60	3-6	0-60	Very gravelly sand	GW or GP	A-1	5-10
Rooset: RsE	>60	>10	0-60	Stony and very stony clay loam.	GC	A-2 or A-6	40-65
Rootel: RtC	20-40	>10	0-23	Channery loam	GM, SM, or ML	A-4	0-5
			23	Argillite bedrock.			
Sappington: SaB, SaC, SgB, SgC	>60	>10	0-60	Loam and gravelly loam	ML or SM	A-4	0-10
Scravo: Sv, Sw	>60	>5	0-17	Cobbly loam and gravelly sandy loam.	GM	A-4	40-50
			17-60	Very gravelly, very cobbly, gravelly, or cobbly loamy sand.	GW-GM or SW-SM	A-1	20-50
*Thess: Te, Ts For Scravo part of Ts, see Scravo series.	>60	>10	0-34	Silt loam or loam	ML	A-4	0
			34-60	Very gravelly sand and cobbly sand.	GW	A-1	30-55
Tolman: TtE	7-20	>10	0-18	Channery clay loam	GC	A-2 or A-4	10-15
			18	Argillite bedrock.			
Toston: Tu	>60	3-6	0-34	Silt loam	CL or ML	A-6 or A-4	0
			34-60	Sandy loam	SM	A-2 or A-4	0
Tropal: TvF Rock outcrop part is too variable to be estimated.	10-20	>10	0-19	Gravelly loam and very gravelly loam.	GM	A-2 or A-4	35-65
			19	Limestone bedrock.			
Ustic Torrifluvents: Uf. Too variable to be estimated.							
Ustic Torriorthents, saline: Ut. Too variable to be estimated.							
Villy: Va, Vd	>60	[3] 0-4	0-60	Silty clay loam	CL	A-6 or A-7	0
Whitore: WhF	40-60	>10	0-40	Channery loam	GM	A-4	25-45
			40-60	Very channery loam	GM	A-1 or A-2	65-75

See footnotes at end of table.

significant to engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Potential frost action	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Untreated steel	Concrete
				Inches per hour	*Inches per inch of soil*	*pH*				
70-100	55-100	50-90	35-75	0.6-2.0	0.11-0.18	7.9-8.4	Low	High	High	Low.
75-90	50-90	50-80	35-65	0.6-2.0	0.11-0.15	7.9-8.4	Low	High	High	Low.
35-50	25-45	15-35	5-15	6.0-20.0	<0.04	7.9-8.4	Low	Low	High	Low.
45-60	30-50	25-45	20-40	0.6-2.0	0.06-0.10	6.6-7.3	Low	Moderate	High	Low.
40-80	35-75	30-70	25-65	0.6-2.0	0.10-0.14	6.6-7.8	Low	Moderate	High	Low.
35-55	25-35	20-30	10-25	0.6-2.0	0.07-0.10	6.6-7.3	Low	Moderate	High	Low.
35-50	25-35	10-25	0-5	6.0-20.0	<0.05	7.3-7.8	Low	Low	High	Low.
65-75	65-75	50-65	35-50	0.6-2.0	0.07-0.10	7.9-8.4	Low	Moderate	High	Low.
40-60	25-50	30-50	15-40	0.6-2.0	0.08-0.12	7.9-8.4	Low	Moderate	High	Low.
40-60	20-35	10-25	0-5	6.0-20.0	<0.04	7.4-7.8	Low	Low	High	Low.
40-60	40-60	35-50	30-45	0.6-2.0	0.07-0.10	6.6-7.8	Low	Moderate	High	Low.
60-85	55-85	45-70	35-65	0.6-2.0	0.12-0.16	7.9-8.4	Low	Moderate	High	Low.
70-90	55-85	50-75	35-65	0.6-2.0	0.11-0.18	7.9-8.4	Low	Moderate	High	Low.
65-75	65-75	50-60	35-50	2.0-6.0	0.07-0.10	6.6-7.3	Low	Low	High	Low.
50-65	30-55	20-30	5-10	6.0-20.0	0.04-0.07	8.0-8.4	Low	Low	High	Low.
85-100	85-100	75-95	65-75	0.6-2.0	0.15-0.20	7.9-8.6	Low	High	High	Low.
35-45	25-35	10-20	0-5	6.0-20.0	<0.05	7.9-8.4	Low	Low	High	Low.
40-60	35-50	30-40	25-40	0.6-2.0	0.10-0.15	7.4-7.8	Low	Moderate	High	Low.
100	100	90-100	70-90	0.06-0.2	0.16-0.20	7.9-9.2	Moderate	High	High	Moderate.
95-100	90-100	60-70	30-40	0.06-0.2	0.12-0.16	7.9-9.0	Low	Moderate	High	Moderate.
40-60	25-50	20-45	15-40	0.6-2.0	0.06-0.12	7.9-8.4	Low	Moderate	Low	Low.
100	100	95-100	85-95	0.2-0.6	0.16-0.20	7.9-8.4	Moderate	High	High	Low.
65-75	55-75	40-70	35-50	0.6-2.0	0.06-0.10	7.9-8.4	Low	Moderate	High	Low.
40-60	25-40	20-35	15-30	0.6-2.0	0.06-0.10	7.9-8.4	Low	Moderate	High	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Percentage larger than 3 inches
	Bedrock	Seasonal water table			Unified	AASHTO	
	Inches	*Feet*	*Inches*				
Windham: WnE	>60	>10	0-60	Very gravelly loam	GM	A-1	35-50
*Woodrock: WoF, WrE	20-40	>10	0-32	Gravelly sandy clay loam	SC	A-6 or A-2	0-15
			32	Igneous bedrock.			
For Loberg part of WoF, see Loberg series. Rock outcrop part of WrE is too variable to be estimated.							

[1] The seasonal water table in all Brocko soils but Brocko silt loam, wet, 0 to 2 percent slopes (BtA), is at a depth of more than 10 feet. In BtA, the seasonal water table is at a depth of 3 to 5 feet.

TABLE 5.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping that appear in the first

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Farm ponds		Agricultural drainage	Irrigation
				Reservoirs	Embankments		
Abor: AbC	Poor: silty clay.	Unsuitable: excessive fines.	Poor: high shrink-swell potential.	Features favorable.	Medium or low shear strength; fair compaction characteristics.	Not needed	Not irrigated
Aeric Fluvaquents: Af. Too variable to be rated. Onsite investigation needed.							
Amesha: AmB, AmC, AnB, AoB, AoC.	Fair: excess lime. Poor in AnB: cobbles.	Unsuitable: excessive fines.	Poor: high potential of frost action.	Permeability is 0.60 to 2.00 inches per hour; slopes are 1 to 9 percent.	Medium shear strength; medium or high piping hazard; fair compaction characteristics.	Not needed	Moderate (in AnB) to severe hazard of soil blowing; slopes are 1 to 9 percent; cobbles in AnB; excess lime.
*Blaine: BcE	Poor: cobbles.	Poor: excessive fines.	Poor: bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches.	Not needed	Not irrigated
For Cheadle part, see Cheadle series.							
Blanyon: BdC	Poor: clay loam texture.	Unsuitable: excessive fines.	Poor: high potential of frost action.	Features favorable.	Medium or low shear strength; low compacted permeability; low or medium piping hazard.	Permeability is 0.20 to 0.60 inch per hour.	Permeability is 0.20 to 0.60 inch per hour; moderate hazard of water erosion.

significant to engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential	Potential frost action	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Untreated steel	Concrete
				Inches per hour	*Inches per inch of soil*	*pH*				
30-50	25-35	20-30	15-25	0.6-2.0	0.06-0.10	7.4-8.4	Low	Moderate	High	Low.
70-85	60-75	35-55	20-40	0.6-2.0	0.08-0.12	6.2-6.6	Low	Moderate	High	Low.

[2] The seasonal water table in Perma very cobbly loam (Pm) is at a depth of more than 6 feet. In Perma very cobbly loam, wet (Pr), it is at a depth of 3 to 5 feet.

[3] The seasonal water table in Villy silty clay loam (Va) is at a depth of 0 to 1.8 feet. In Villy silty clay loam, drained (Vd), it is at a depth of 2.5 to 4 feet.

engineering properties of the soils

units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series column of this table]

Soil features affecting—*Continued*	Degree of limitation for—							
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	Dwellings		Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
			With basements	Without basements				
Permeability is 0.06 to 0.20 inch per hour; shale at a depth of 20 to 40 inches.	Severe: permeability is 0.06 to 0.20 inch per hour; shale at a depth of 20 to 40 inches.	Moderate if slopes are 3 to 7 percent, severe if 7 to 9 percent.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: clayey.	Severe: clay shale at a depth of 20 to 40 inches.	Severe: clayey; clay shale at a depth of 20 to 40 inches.
Moderate (in AnB) to severe hazard of soil blowing; excess lime.	Slight if slopes are 1 to 8 percent, moderate if 8 to 9 percent.	Moderate if slopes are 1 to 7 percent; permeability is 0.60 inch to 2.00 inches per hour. Severe if slopes are 7 to 9 percent.	Slight if slopes are 1 to 8 percent, moderate if 8 to 9 percent.	Slight if slopes are 1 to 8 percent, moderate if 8 to 9 percent.	Severe: high potential of frost action.	Slight	Slight if slopes are 1 to 8 percent, moderate if 8 to 9 percent. Moderate in AnB: cobbles.	Slight.
Not needed	Severe: bedrock at a depth of 20 to 40 inches; slopes.	Severe: slopes are 10 to 25 percent; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate if slopes are 10 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 25 percent.	Moderate if slopes are 10 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 25 percent.	Moderate if slopes are 10 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 25 percent.	Severe: bedrock at a depth of 20 to 40 inches; slopes are 10 to 25 percent.	Severe: bedrock at a depth of 20 to 40 inches.
Features favorable.	Severe: permeability is 0.20 to 0.60 inch per hour.	Moderate if slopes are 3 to 7 percent, severe if 7 to 10 percent.	Moderate: moderate shrink-swell potential; slopes are 8 to 10 percent in some areas.	Moderate: moderate shrink-swell potential; slopes are 8 to 10 percent in some areas.	Severe: high potential of frost action.	Moderate: clay loam texture.	Moderate: clay loam texture; slopes are 8 to 10 percent in some areas.	Moderate: clay loam texture.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
Borohemists: Bo. Too variable to be rated. Onsite investigation needed.							
Bridger: BpD, BrD	Good if slopes are 5 to 8 percent, fair if 8 to 15 percent. Poor in BpD: cobbles.	Unsuitable: excessive fines.	Fair: moderate shrink-swell potential; moderate potential of frost action; medium shear strength.	Slopes are 5 to 15 percent.	Medium shear strength; low compacted permeability; medium to low piping hazard.	Features favorable.	Moderate or severe hazard of water erosion; cobbles in BpD.
Brocko: BsA, BsB, BsC, BsD, BtA.	Fair: excess lime.	Unsuitable: excessive fines.	Poor: high potential of frost action.	Permeability is 0.60 inch to 2.00 inches per hour; seasonal water table in BtA at a depth of 3 to 5 feet.	Medium shear strength; high piping hazard; medium or low compacted permeability.	Ditchbanks highly erodible.	Severe hazard of soil blowing; slopes are 0 to 25 percent; seasonal water table in BtA at a depth of 3 to 5 feet; excess lime.
Cabbart: CaE	Poor: soft siltstone or sandstone at a depth of 10 to 20 inches.	Unsuitable: excessive fines.	Poor: soft siltstone or sandstone at a depth of 10 to 20 inches; high potential of frost action.	Soft siltstone or sandstone at a depth of 10 to 20 inches; slopes are 9 to 35 percent.	Medium or low shear strength; medium or low compacted permeability; high piping hazard; soft siltstone or sandstone at a depth of 10 to 20 inches.	Not needed	Not irrigated
Cheadle: CdE	Poor: bedrock at a depth of 7 to 20 inches; more than 15 percent channers.	Poor: excessive fines.	Poor: bedrock at a depth of 7 to 20 inches.	Bedrock at a depth of 7 to 20 inches; seepage in fractured bedrock.	Bedrock at a depth of 7 to 20 inches; many stones.	Not needed	Not irrigated
*Chinook: ChB, ChC, CmC, CnC, CnE. For Crago part of CmC, CnC, and CnE, see Crago series.	Good if slopes are 1 to 8 percent, fair if 8 to 15 percent, poor if more than 15 percent. Poor in CmC: loamy sand texture. Poor in CnC and CnE: more than 15 percent cobbles.	Unsuitable: excessive fines.	Fair: excessive fines; moderate potential of frost action.	Permeability is 2.0 to 6.0 inches per hour; slopes are 1 to 35 percent.	Medium piping hazard; medium shear strength.	Features favorable; not needed in CmC, CnC, and CnE.	Moderate or severe hazard of soil blowing; slopes are 1 to 35 percent; CmC is droughty.

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	Dwellings		Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
			With basements	Without basements				
Moderate or severe hazard of water erosion.	Slight if slopes are 5 to 8 percent, moderate if 8 to 15 percent.	Moderate if slopes are 5 to 7 percent, severe if 7 to 15 percent.	Moderate: moderate shrink-swell potential; slopes are 8 to 15 percent in some areas.	Moderate: moderate shrink-swell potential; slopes are 8 to 15 percent in some areas.	Moderate: moderate shrink-swell potential; moderate potential of frost action.	Moderate: slopes are 5 to 15 percent.	Slight if slopes are 5 to 8 percent, moderate if 8 to 15 percent. Moderate in BpD: cobbles.	Slight.
Severe hazard of soil blowing; slopes are 0 to 25 percent; seasonal water table in BtA at a depth of 3 to 5 feet; excess lime.	Slight or moderate if slopes are 1 to 8 percent; permeability is 0.60 inch to 2.00 inches per hour. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 25 percent. Severe in BtA: seasonal water table at a depth of 3 to 5 feet.	Moderate if slopes are 2 to 7 percent; permeability is 0.60 inch to 2.00 inches per hour. Severe if slopes are 7 to 25 percent. Severe in BtA: seasonal water table at a depth of 3 to 5 feet.	Severe: high potential of frost action.	Severe: high potential of frost action.	Severe: high potential of frost action.	Slight if slopes are 0 to 5 percent, moderate if 5 to 15 percent, severe if 15 to 25 percent.	Slight if slopes are 0 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent. Moderate in BtA: seasonal water table at a depth of 3 to 5 feet.	Slight if slopes are 0 to 15 percent, moderate if 15 to 25 percent. Severe in BtA: seasonal water table at a depth of 3 to 5 feet.
Not needed ----	Severe: soft siltstone or sandstone at a depth of 10 to 20 inches.	Severe: slopes are 9 to 35 percent.	Moderate if slopes are 9 to 15 percent; soft siltstone or sandstone at a depth of 10 to 20 inches. Severe if slopes are more than 15 percent.	Moderate if slopes are 9 to 15 percent; soft siltstone or sandstone at a depth of 10 to 20 inches. Severe if slopes are more than 15 percent.	Severe: high potential of frost action.	Moderate if slopes are 9 to 15 percent; soft siltstone or sandstone at a depth of 10 to 20 inches. Severe if slopes are more than 15 percent.	Severe: soft siltstone or sandstone at a depth of 10 to 20 inches.	Severe: soft siltstone or sandstone at a depth of 10 to 20 inches.
Not needed ----	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.	Severe: bedrock at a depth of 7 to 20 inches.
Moderate or severe hazard of soil blowing; slopes are 1 to 35 percent; CmC is droughty.	Slight if slopes are 1 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: permeability is 2.0 to 6.0 inches per hour.	Slight if slopes are 1 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Slight if slopes are 1 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Moderate if slopes are 1 to 15 percent; moderate potential of frost action. Severe if slopes are more than 15 percent.	Slight in all but CnC and CnE; moderate in CnC and CnE if cobbly; severe in CnC if loamy sand textures; severe in CnE if slopes are more than 15 percent.	Slight if slopes are 1 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: permeability is 2.0 to 6.0 inches per hour.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Farm ponds		Agricultural drainage	Irrigation
				Reservoirs	Embankments		
Chinook variant: CkB	Fair: very gravelly loamy sand at a depth of 20 to 35 inches.	Good: well-graded gravel below a depth of 20 to 25 inches.	Fair: moderate potential of frost action.	Permeability is 6.0 to 20 inches per hour below a depth of 20 to 35 inches.	Medium piping hazard; medium or high shear strength; medium compacted permeability.	Features favorable.	Severe hazard of soil blowing; very gravelly loamy sand at a depth of 20 to 35 inches.
Crago: CrC	Poor: more than 15 percent cobbles and gravel.	Fair: excessive fines.	Fair: moderate potential of frost action.	Permeability is 6.0 to 20.0 inches per hour within a depth of 5 feet.	Medium compacted permeability; low or medium piping hazard.	Not needed	Moderate or severe hazard of soil blowing; permeability is 6.0 to 20.0 inches per hour; slopes are 4 to 35 percent; droughty; 15 to 50 percent gravel and cobbles.
*Delphill: DeB, DhD. For Abor part of DhD, see Abor series.	Fair: soft siltstone or shale at a depth of 20 to 40 inches.	Unsuitable: excessive fines.	Poor: high potential of frost action; soft siltstone or shale at a depth of 20 to 40 inches.	Features favorable.	Medium to low shear strength; medium or high piping hazard; medium or low compacted permeability; soft siltstone or shale at a depth of 20 to 40 inches.	Not needed	Not irrigated
Dominic: Do	Poor: 50 percent or more cobbles or gravel.	Good	Good	Permeability is 6.0 to 20.0 inches per hour.	High compacted permeability; 50 percent or more cobbles or gravel.	Features favorable.	Permeability is 6.0 to 20.0 inches per hour; 50 percent or more cobbles or gravel; droughty.
*Ess: EcF. For Cheadle part, see Cheadle series.	Poor: slopes are 35 to 60 percent; 50 percent or more stones, cobbles, or gravel; stony surface.	Unsuitable: excessive fines.	Poor: slopes are 35 to 60 percent.	Slopes are 35 to 60 percent.	Medium compacted permeability; 50 percent or more stones, cobbles, or gravel; medium piping hazard.	Not needed	Not irrigated
*Fairdale: Fa, Fb. For Lothair part of Fb, see Lothair series.	Good for Fa. Fair for Fb: silty clay texture in upper 10 to 15 inches.	Poor above a depth of 6 feet; excessive fines. Good below a depth of 6 to 10 feet; seasonal water table at a depth of 3 to 6 feet.	Poor: high potential of frost action.	Seasonal water table at a depth of 3 to 6 feet.	Medium piping hazard; medium or low shear strength; medium or low compacted permeability.	Features favorable.	Seasonal water table at a depth of 3 to 5 feet.

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	Dwellings		Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
			With basements	Without basements				
Severe hazard of soil blowing; very gravelly loamy sand at a depth of 20 to 35 inches.	Slight	Severe: permeability is 6.0 to 20.0 inches per hour below a depth of 20 to to 35 inches.	Slight	Slight	Moderate potential of frost action.	Slight	Slight	Severe: permeability is 6.0 to 20.0 inches per hour below a depth of 20 to 35 inches.
Moderate or severe hazard of soil blowing; permeability is 6.0 to 20.0 inches per hour; slopes are 4 to 35 percent; droughty; 15 to 50 percent gravel and cobbles.	Slight if slopes are 4 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: permeability is 6.0 to 20.0 inches per hour.	Slight if slopes are 4 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Slight if slopes 4 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Moderate: moderate potential of frost action. Severe if slopes are more than 15 percent.	Moderate if slopes are less than 15 percent; permeability is 6.0 to 20 inches per hour; droughty; 15 to 50 percent cobbles and gravel. Severe if slopes are more than 15 percent.	Slight if slopes are 4 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: permeability is 6.0 to 20.0 inches per hour.
Soft siltstone or shale at a depth of 20 to 40 inches.	Severe: soft siltstone or shale at a depth of 20 to 40 inches.	Severe: soft siltstone or shale at a depth of 20 to 40 inches.	Moderate if slopes are less than 15 percent; soft siltstone or shale at a depth of 20 to 40 inches. Severe if slopes are more than 15 percent.	Moderate if slopes are less than 15 percent; soft siltstone or shale at a depth of 20 to 40 inches. Severe if slopes are more than 15 percent.	Severe: high potential of frost action.	Slight if slopes are 1 to 5 percent, moderate if 5 to 15 percent, severe if more than 15 percent.	Severe: soft siltstone or shale at a depth of 20 to 40 inches.	Severe: soft siltstone or shale at a depth of 20 to 40 inches.
Not needed	Generally slight. Severe on areas near streams: subject to flooding in some years.	Severe: permeability is 6.0 to 20.0 inches per hour.	Generally slight. Severe on areas near streams: subject to flooding in some years.	Generally slight. Severe on areas near streams: subject to flooding in some years.	Generally slight. Severe on areas near streams: subject to flooding in some years.	Severe: droughty; 50 percent or more cobbles or gravel.	Generally slight. Severe on areas near streams: subject to flooding in some years.	Severe: permeability is 6.0 to 20.0 inches per hour.
Not needed	Severe: slopes are 35 to 60 percent.	Severe: slopes are 35 to 60 percent; 50 percent or more stones, cobbles, or gravel.	Severe: slopes are 35 to 60 percent; stones.	Severe: slopes are 35 to 60 percent; stones.	Severe: slopes are 35 to 60 percent; stones.	Severe: slopes are 35 to 60 percent.	Severe: slopes are 35 to 60 percent.	Severe: slopes are 35 to 60 percent; stones.
Features favorable.	Severe: seasonal water table at a depth of 3 to 5 feet.	Severe: seasonal water table at a depth of 3 to to 6 feet.	Moderate: seasonal water table at a depth of 3 to 5 feet.	Slight	Severe: high potential of frost action.	Slight	Severe: seasonal water table at a depth of 3 to 5 feet.	Severe: seasonal water table at a depth of 3 to to 5 feet.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
Fluvaquentic Haplaquolls: Fd. Too variable to be rated. Onsite investigation needed.							
Havre: Ha	Good	Poor above a depth of 5 feet; excessive fines. Good below a depth of 5 to 10 feet; seasonal water table at a depth of 5 to 10 feet.	Poor: high potential of frost action.	Permeability is 0.6 inch to 2.0 inches per hour.	High piping hazard; medium to low shear strength; medium to low compacted permeability.	Features favorable.	Features favorable.
Hilger: HgE	Poor: 35 to 50 percent stones and cobbles.	Unsuitable: excessive fines.	Fair: moderate potential of frost action; extremely stony surface layer.	Slopes are 8 to 25 percent; 35 to 50 percent stones and cobbles.	Medium shear strength; low compacted permeability; medium or low piping hazard; 10 to 25 percent stones.	Not needed	Not irrigated
Lake Creek: LaF	Poor: 35 to 50 percent channers; slopes are 20 to 50 percent.	Unsuitable: excessive fines.	Poor: bedrock at a depth of 20 to 40 inches; slopes are 20 to 50 percent.	Slopes are 20 to 50 percent; bedrock at a depth of 20 to 40 inches.	Fractured bedrock at a depth of 20 to 40 inches; medium piping hazard.	Not needed	Not irrigated
Loberg: LoE	Poor: 15 to 35 percent stones and channers on surface; 15 to 70 percent channers and stones below 20 inches.	Unsuitable: excessive fines.	Fair if slopes are less than 25 percent; moderate potential of frost action. Poor if slopes are 25 to 35 percent.	Slopes are 10 to 35 percent.	Medium shear strength; medium piping hazard; medium or low compacted permeability.	Not needed	Not irrigated
Lothair: Lt	Poor: silty clay loam texture.	Unsuitable: excessive fines.	Fair: moderate potential of frost action; moderate shrink-swell potential.	Features favorable.	Low shear strength; low compacted permeability.	Permeability is 0.06 to 0.20 inch per hour; unstable ditchbanks.	Permeability is 0.06 to 0.20 inch per hour; slow intake rate.
Martinsdale: MaB, MaC, McC	Generally fair: 15 to 50 percent channers below a depth of 16 inches. Poor for McC: cobbles and channers.	Unsuitable: excessive fines.	Poor: high potential of frost action.	Permeability is 0.6 to 2.0 inches per hour; slopes are 2 to 9 percent.	Medium shear strength; medium or low compacted permeability; high or medium piping hazard; poor or fair compaction characteristics.	Features favorable.	Moderate hazard of water erosion; 15 to 50 percent channers; below a depth of 16 inches, 15 to 50 percent cobbles and channers in McC.
Mine dumps: Md. Too variable to be rated. Onsite investigation needed.							

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	Dwellings		Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
			With basements	Without basements				
Features favorable.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Severe: hazard of flooding.	Slight	Severe: hazard of flooding.	Severe: hazard of flooding.
Not needed	Moderate if slopes are 8 to 15 percent, severe if 15 to 25 percent.	Severe: slopes are 8 to 25 percent.	Moderate if slopes are 8 to 15 percent; 10 to 25 percent stones. Severe if slopes are 15 to 25 percent.	Moderate if slopes are 8 to 15 percent; 10 to 25 percent stones. Severe if slopes are 15 to 25 percent.	Moderate if slopes are 8 to 15 percent; moderate potential frost action; severe if slopes are 15 to 25 percent.	Severe: 35 to 50 percent stones and cobbles.	Moderate if slopes are 8 to 15 percent, severe if more than 15 percent.	Moderate if slopes are 8 to 15 percent; 35 to 50 percent stones and cobbles. Severe if slopes are 15 to 25 percent.
Not needed	Severe: bedrock at a depth of 20 to 40 inches; slopes are 20 to 50 percent.	Severe: bedrock at a depth of 20 to 40 inches; slopes are 20 to 50 percent.	Severe: bedrock at a depth of 20 to 40 inches; slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent.	Severe: slopes are 20 to 50 percent; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.
Not needed	Moderate if slopes are 10 to 15 percent, severe if 15 to 35 percent.	Severe: slopes are 10 to 35 percent.	Moderate if slopes are 10 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 10 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 10 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 10 to 15 percent; 15 to 35 percent channers and stones on the surface. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 10 to 15 percent; 15 to 70 percent channers and stones below 20 inches. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 10 to 15 percent; 15 to 70 percent channers and stones below 20 inches. Severe if slopes are 15 to 35 percent.
Permeability is 0.06 to 0.20 inch per hour; slow intake rate; silty clay texture.	Severe: permeability is 0.06 to 0.20 inch per hour.	Slight	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Moderate: moderate shrink-swell potential; moderate potential of frost action.	Severe: silty clay texture.	Severe: silty clay texture.	Severe: silty clay texture.
Moderate hazard of water erosion; 15 to 50 percent channers; below a depth of 16 inches, 15 to 50 percent cobbles and channers in McC.	Slight if slopes are 2 to 8 percent; moderate if 8 to 9 percent.	Moderate if slopes are 2 to 7 percent; permeability is 0.6 inch to 2.0 inches per hour. Severe if slopes are 7 to 9 percent.	Slight if slopes are 2 to 8 percent; moderate if 8 to 9 percent.	Slight if slopes are 2 to 8 percent; moderate if 8 to 9 percent.	Severe: high potential of frost action.	Slight if slopes are 2 to 5 percent; moderate if 5 to 9 percent and if surface layer is cobbly.	Slight if slopes are 2 to 8 percent; moderate if 8 to 9 percent; cobbles in McC.	Slight.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
*Mussel: MsA, MsB, Mt, MuB, MuC. For Crago part of Mt, see Crago series; for Musselshell part of MuB and MuC, see Musselshell series.	Good	Unsuitable to a depth of 5 to 8 feet; excessive fines. Good or fair below.	Poor: high potential frost action.	Permeability is 0.6 inch to 2.0 inches per hour; slopes are 0 to 9 percent.	High piping hazard; medium shear strength; low compacted permeability.	Features favorable.	Severe hazard of soil blowing; moderate hazard of water erosion in MuC.
*Musselshell: MvB, MvC, MwE, MxE, MyC. For Crago part of MwE and MxE, see Crago series; for Thess part of MyC, see Thess series.	Poor: 15 to 35 percent gravel, channers, or cobbles. Slopes are 15 to 20 percent in MxE.	Poor to a depth of 35 inches: excessive fines. Good below a depth of 35 inches.	Poor to a depth of 43 inches: high potential of frost action. Good below a depth of 43 inches.	To a depth of 43 inches, permeability is 0.6 inch to 2.0 inches per hour and 15 to 35 percent gravel, channers, or cobbles. Below a depth of 43 inches, permeability is 6 to 20 inches per hour, more than 50 percent gravel, channers, or cobbles.	To a depth of 43 inches, medium shear strength, medium compacted permeability, and medium piping hazard. Below a depth of 43 inches, high shear strength, high compacted permeability, and low piping hazard.	Features favorable.	To a depth of 43 inches, 15 to 35 percent gravel, channers, or cobbles; permeability is 6 to 20 inches per hour. Below a depth of 43 inches, moderate hazards of soil blowing and erosion in all but MwE, severe hazards of soil blowing and erosion in MxE.
Nielsen: NeF	Poor: 35 to 60 percent channers; bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Unsuitable: excessive fines.	Poor: hard bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Medium shear strength; medium compacted permeability; medium piping hazard.	Not needed	Not irrigated
*Passcreek: PaD, PcE For Lake Creek part of PcE, see Lake Creek series.	Poor: 15 to 50 percent gravel.	Unsuitable: excessive fines.	Poor: bedrock at a depth of depth of 20 to 40 inches.	Fractured bedrock at a depth of 20 to 40 inches; slopes are 6 to 35 percent.	Medium shear strength; medium or low compacted permeability; medium piping hazard.	Not needed	Not irrigated
Perma: Pm, Pr	Poor: more than 50 percent cobbles and gravel.	Poor to a depth of 43 inches; excessive fines. Good below a depth of 43 inches; seasonal high water table at a depth of 3 to 5 feet in Pr.	Good	Permeability is 0.6 inch to 2.0 inches per hour to a depth of 43 inches and 6.0 to 20.0 inches per hour below that depth; slopes are 2 to 5 percent.	Medium or high shear strength; medium or low compacted permeability; medium to low piping hazard.	Features favorable.	Permeability is 6.0 to 20.0 inches per hour below a depth of 43 inches; droughty; 50 percent or more cobbles and gravel.

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
			Dwellings					
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	With basements	Without basements	Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
Severe hazard of soil blowing; moderate hazard of water erosion in MuC.	Slight if slopes are 0 to 8 percent; moderate if 8 to 9 percent.	Moderate if slopes are less than 7 percent; permeability is 0.6 inch to 2.0 inches per hour. Severe if slopes are 7 to 9 percent.	Slight if slopes are 0 to 8 percent; moderate if 8 to 9 percent.	Slight if slopes are 0 to 8 percent; moderate if 8 to 9 percent.	Severe: high potential of frost action.	Slight if slopes are 0 to 5 percent; moderate if 5 to 9 percent.	Slight if slopes are 0 to 8 percent; moderate if 8 to 9 percent.	Generally slight. Severe in trenches nearly 8 feet deep because of rapid permeability.
Excess lime; moderate hazards of soil blowing and water erosion; severe hazard of water erosion in MwE.	Slight if slopes are 2 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 35 percent.	Severe: permeability is 0.6 inch to 2.0 inches per hour to a depth of 43 inches, 6 to 20 inches below a depth of 43 inches; slopes are 7 to 35 percent.	Slight if slopes are 2 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 35 percent.	Slight if slopes are 2 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 35 percent.	Severe: high potential of frost action.	Slight if slopes are 2 to 5 percent, moderate if 5 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are less than 15 percent; 15 to more than 50 percent gravel or cobbles. Severe if slopes are 15 to 35 percent.	Severe: permeability is 6 to 20 inches per hour below a depth of 43 inches.
Not needed----	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.
Not needed----	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate if slopes are 6 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 6 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 6 to 15 percent; bedrock at a depth of 20 to 40 inches. Severe if slopes are 15 to 35 percent.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.
Not needed ----	Slight in Pm. Severe in Pr: seasonal high water table at a depth of 3 to 5 feet.	Severe: permeability is 6.0 to 20.0 inches per hour below a depth of 43 inches; 50 percent or more cobbles and gravel.	Slight in Pm. Severe in Pr: seasonal high water table at a depth of 3 to 5 feet.	Slight ----------	Moderate: moderate potential of frost action to a depth of 43 inches.	Severe: 50 to 70 percent cobbles and gravel; permeability is 6.0 to 20.0 inches per hour below a depth of 43 inches; droughty.	Severe: more than 50 percent cobbles and gravel; seasonal high water table at a depth of 3 to 5 feet in Pr.	Severe: rapid permeability below a depth of 43 inches; seasonal high water table at a depth of 3 to 5 feet in Pr.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
Radersburg: Ra	Poor: more than 50 percent cobbles, gravel, and some stones.	Poor: excessive fines.	Fair: moderate potential of frost action.	Permeability is 0.6 inch to 2.0 inches per hour; more than 50 percent cobbles, gravel, and some stones.	Medium shear strength; medium compacted permeability; medium piping hazard; more than 50 percent cobbles, gravel, and some stones.	Not needed	More than 50 percent cobbles, gravel, and some stones; droughty.
Rencot: ReE	Poor: 35 to 65 percent channers; slopes are 15 to 35 percent; bedrock at a depth of 10 to 20 inches.	Unsuitable: excessive fines.	Poor: bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches; 35 to 65 percent channers.	Fractured bedrock at a depth of 10 to 20 inches.	Not needed	Not irrigated
Rivra: Rr	Poor: more than 15 percent gravel.	Good: seasonal high water table at a depth of 3 to 6 feet; subject to overflow.	Good	Permeability is 6 to 20 inches per hour; seasonal high water table at a depth of 3 to 6 feet.	High compacted permeability; high shear strength.	Not needed	Not irrigated
Rooset: RsE	Poor: 35 to 70 percent stones.	Unsuitable: excessive fines.	Poor: 35 to 70 percent stones.	Permeability is 0.6 inch to 2.0 inches per hour; slopes are 9 to 35 percent; 35 to 70 percent stones.	Medium shear strength; low compacted permeability; medium piping hazard; 35 to 70 percent stones.	Not needed	Not irrigated
Rootel: RtC	Poor: 15 to 35 percent channers.	Unsuitable: excessive fines.	Poor: hard bedrock at a depth of 20 to 40 inches.	Fractured bedrock at a depth of 20 to 40 inches.	Medium shear strength; medium or low compacted permeability; medium piping hazard.	Not needed	Not irrigated
Sappington: SaB, SaC, SgB, SgC	Fair: excessive lime at a depth of 8 to 10 inches; 15 to 35 percent gravel in SgB and SgC.	Unsuitable: excessive fines.	Fair: moderate potential of frost action.	Permeability is 0.6 inch to 2.0 inches per hour; slopes are 2 to 9 percent.	Medium shear strength; medium or high piping hazard; low or medium compacted permeability.	Features favorable.	Slopes are 2 to 9 percent; moderate hazard of water erosion in SaC and SgC; 15 to 35 percent gravel in SgB and SgC.
Scravo: Sv, Sw	Poor: 15 to 35 percent cobbles and gravel to a depth of 17 inches, 30 to 60 percent below.	Fair to a depth of 17 inches; excessive fines. Good below a depth of 17 inches.	Good	Permeability is 6 to 20 inches per hour below a depth of 17 inches.	High compacted permeability; high shear strength; low or medium piping hazard.	Features favorable.	Permeability is 6.0 to 20.0 inches per hour; droughty.

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
			Dwellings					
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	With basements	Without basements	Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
More than 50 percent cobbles, gravel, and some stones; droughty.	Slight	Moderate: permeability is 0.6 inch to 2.0 inches per hour.	Slight	Slight	Moderate: moderate potential of frost action.	Severe: 50 percent or more cobbles, gravel, and some stones; droughty.	Moderate: 50 percent or more cobbles, gravel, and some stones.	Moderate: large volume of cobbles, some stones.
Not needed	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches.
Not needed	Severe: subject to overflow; seasonal high water table at a depth of 3 to 6 feet.	Severe: permeability is 6 to 20 inches per hour; subject to flooding; water table at a depth of 3 to 6 feet.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: permeability is 6 to 20 inches per hour; droughty.	Severe: seasonal high water table at a depth of 3 to 6 feet; hazard of flooding.	Severe: water table at a depth of 3 to 6 feet; hazard of flooding; permeability is 6.0 to 20.0 inches per hour.
Not needed	Severe: 35 to 70 percent stones.	Severe: 35 to 70 percent stones; slopes are 9 to 35 percent.	Severe: 35 to 70 percent stones.	Severe: 35 to 70 percent stones.	Severe: 35 to 70 percent stones.	Severe: 35 to 70 percent stones; droughty.	Severe: 35 to 70 percent stones.	Severe: 35 to 70 percent stones.
Not needed	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.
Slopes are 2 to 9 percent; excessive lime at a depth of 10 inches.	Slight if slopes are 2 to 8 percent, moderate if 8 to 9 percent.	Moderate if slopes are 2 to 7 percent: permeability is 0.6 inch to 2.0 inches per hour; severe if slopes are 7 to 9 percent.	Slight if slopes are 2 to 8 percent, moderate if 8 to 9 percent.	Slight if slopes are 2 to 8 percent, moderate if 8 to 9 percent.	Moderate: moderate potential of frost action.	Moderate: clay loam texture.	Moderate: clay loam texture.	Slight.
Permeability is 6.0 to 20.0 inches per hour; droughty.	Slight	Severe: permeability is 6 to 20 inches per hour.	Slight	Slight	Slight	Severe: permeability is 6.0 to 20.0 inches per hour; droughty.	Moderate: 15 to 60 percent cobbles and gravel.	Severe: rapid permeability.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
*Thess: Te, Ts For Scravo part of Ts, see Scravo series.	Fair: sand at depth of 20 to 35 inches; 70 percent gravel; excessive lime.	Poor to a depth of 35 inches; excessive fines. Good below a depth of 35 inches.	Poor to a depth of 35 inches; high potential of frost action. Good below a depth of 35 inches.	Permeability is 6.0 to 20.0 inches per hour below a depth of 35 inches.	Medium compacted permeability; medium piping hazard; medium shear strength.	Features favorable.	Permeability is 6.0 to 20.0 inches below a depth of 35 inches; droughty.
Tolman: TtE	Bedrock at a depth of 10 to 20 inches; 35 to 50 percent channers.	Unsuitable: excessive fines.	Poor: bedrock at a depth of 10 to 20 inches.	Fractured bedrock at a depth of 7 to 20 inches.	Fractured bedrock at a depth of 10 to to 20 inches.	Not needed	Not irrigated
Toston: Tu	Poor: excessive salts.	Poor to a depth of 4 to 8 feet; excessive fines. Good below a depth of 4 to 8 feet; seasonal high water table at a depth of 3 to 6 feet.	Poor: high potential of frost action to a depth of 4 to 8 feet.	Seasonal high water table at a depth of 3 to 6 feet; seepage.	High piping hazard; low shear strength; medium or low compacted permeability.	Permeability is 0.06 to 0.20 inch per hour; unstable ditchbanks; seasonal high water table at a depth of 3 to 6 feet.	Permeability is 0.06 to 0.20 inch per hour; slow intake rate; excessive salts; seasonal high water table at a depth of 3 to 6 feet; excessive salts.
Tropal: TvF Rock outcrop part is too variable to estimate.	Poor: bedrock at a depth of 7 to 20 inches; 30 to 65 percent gravel and cobbles; slopes are 15 to 60 percent.	Unsuitable: excessive fines.	Poor: bedrock at a depth of 7 to 20 inches.	Bedrock at a depth of 10 to 20 inches.	Bedrock at a depth of 10 to 20 inches.	Not needed	Not irrigated
Ustic Torrifluvents: Uf Too variable to be rated. Onsite investigation needed.							
Ustic Torriorthents, saline: Ut Too variable to be rated. Onsite investigation needed.							
Villy: Va, Vd	Poor in Va: seasonal high water table at a depth of 0 to 20 inches. Fair in Vd: silty clay loam texture; seasonal high water table at a depth of 30 to 48 inches.	Unsuitable: excessive fines.	Poor: high potential of frost action; seasonal high water table at a depth of 0 to 20 inches in Va, 30 to 48 inches in Vd.	Seasonal high water table at a depth of 0 to 20 inches in Va, 30 to 48 inches in Vd.	Low shear strength; low compacted permeability; medium piping hazard.	Permeability is 0.20 to 0.60 inch per hour; unstable ditchbanks; seasonal high water table at a depth of 0 to 20 inches in Va, 30 to 48 inches in Vd.	Permeability is 0.20 to 0.60 inch per hour; seasonal high water table at a depth of 0 to 20 inches in Va, 30 to 48 inches in Vd.
Whitore: WhF	Poor: 15 to 60 percent gravel, cobbles, and stones; slopes are 25 to 60 percent.	Unsuitable: excessive fines.	Poor: slopes are 25 to 60 percent.	Slopes are 25 to 60 percent.	Medium piping hazard; medium or high shear strength; medium compacted permeability.	Not needed	Not irrigated

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
			Dwellings					
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	With basements	Without basements	Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
Permeability is 6.0 to 20.0 inches below a depth of 35 inches; droughty; excessive lime.	Slight	Severe: permeability is 6.0 to 20.0 inches per hour.	Slight	Slight	Severe: high potential of frost action.	Moderate: excessive lime.	Slight	Severe: permeability is 6.0 to 20.0 inches below a depth of 35 inches.
Not needed	Severe: bedrock at a depth of 10 to 20 inches.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 10 to 35 percent.	Severe: bedrock at a depth of 10 to 20 inches.
Excessive salts; seasonal high water table at a depth of 3 to 6 feet.	Severe: permeability is 0.06 to 0.20 inch per hour; seasonal high water table at a depth of 3 to 6 feet.	Severe: seasonal high water table at a depth of 3 to 6 feet.	Moderate: seasonal high water table at a depth of 3 to 6 feet.	Slight	Severe: high potential of frost action.	Severe: excessive salts.	Severe: seasonal high water table at a depth of 3 to 6 feet.	Severe: seasonal high water table at a depth of 3 to 6 feet.
Not needed	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 10 to 20 inches; slopes are 15 to 60 percent.
Seasonal high water table is at a depth of 0 to 20 inches in Va, 30 to 48 inches in Vd.	Severe: seasonal high water table at a depth of 0 to 48 inches; permeability 0.20 to 0.6 inch per hour.	Severe in Va: seasonal high water table at a depth of 0 to 20 inches. Slight in Vd.	Severe in Va: seasonal high water table at a depth of 0 to 20 inches. Moderate in Vd: seasonal high water table at a depth of 30 to 48 inches.	Severe in Va: seasonal high water table at a depth of 0 to 20 inches. Slight in Vd.	Severe: high potential of frost action; seasonal high water table at a depth of 0 to 20 inches in Va.	Severe in Va: seasonal high water table at a depth of 0 to 20 inches. Moderate in Vd: silty clay loam texture.	Severe: seasonal high water table at a depth of 0 to 48 inches.	Severe: seasonal high water table at a depth of 0 to 48 inches.
Not needed	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent.	Severe: slopes are 25 to 60 percent; bedrock at a depth of 40 to 60 inches.	Severe: slopes are 25 to 60 percent; bedrock at a depth of 40 to 60 inches.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
				Farm ponds			
	Topsoil	Sand and gravel	Road fill	Reservoirs	Embankments	Agricultural drainage	Irrigation
Windham: WnE	Poor: 15 to 35 percent cobbles and gravel.	Poor: excessive fines.	Fair if slopes are less than 25 percent: moderate potential of frost action. Poor if slopes are 25 to 35 percent.	Permeability is 0.6 inch to 2.0 inches per hour; slopes are 9 to 35 percent.	High to medium shear strength; medium to low compacted permeability; medium to low piping hazard.	Not needed	Not irrigated
*Woodrock: WoF, WrE. For Loberg part of WoF, see Loberg series; Rock outcrop part of WrE is too variable to be rated.	Poor: slopes are 15 to 60 percent.	Unsuitable: excessive fines.	Poor: bedrock at a depth of 20 to 40 inches.	Permeability is 0.6 inch to 2.0 inches per hour; bedrock at a depth of 20 to 40 inches; slopes are 15 to 60 percent.	Bedrock at a depth of 20 to 40 inches; medium shear strength; low compacted permeability; low piping hazard.	Not needed	Not irrigated

ence of stones or organic material in a soil are among the unfavorable factors.

Agricultural drainage is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope susceptibility to stream overflow, erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces, waterways, and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect the suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to erosion, soil slipping, and soil blowing. A soil that is suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Septic-tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties that affect the pond floor and the embankment are considered. Those that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Dwellings, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Roads and parking areas, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material—a base of gravel, crushed rock, or soil material stabilized

properties of the soils—Continued

Soil features affecting—*Continued*	Degree of limitation for—							
Terraces, waterways, and diversions	Septic tank absorption fields	Sewage lagoons	Dwellings		Roads and parking areas	Lawns	Shallow excavations	Sanitary landfills
			With basements	Without basements				
Not needed ----	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.	Severe: slopes are 9 to 35 percent.	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 9 to 15 percent; moderate potential of frost action. Severe if slopes are 15 to 35 percent.	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.	Moderate if slopes are 9 to 15 percent, severe if 15 to 35 percent.
Not needed ----	Severe: bedrock at a depth of 20 to 40 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 20 to 40 inches; slopes are 15 to 60 percent.	Severe: bedrock at a depth of 20 to 40 inches; slopes are 15 to 60 percent.	Severe: slopes are 15 to 60 percent.	Severe: slopes are 15 to 60 percent.	Severe: slopes are 15 to 60 percent.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.

with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and parking areas are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Properties that affect limitations for lawns are depth to bedrock, seasonal high water table, coarse fragments, slope, soil texture, and salinity or alkalinity.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Sanitary landfills are methods of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet; therefore, limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet; but regardless of that, every site should be investigated before it is selected.

Formation and Classification of Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in the Broadwater County Area. The second explains the system of soil classification currently in use and places each soil series in the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic processes. The characteristics of the soil at any given point are determined by the physical and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of

rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

All material from which soil has formed was derived from weathered bedrock that was either local or transported from other areas. The material may have weathered from rock directly beneath the soil or may have been moved by gravity, wind, or water to its present location. Residuum derived from bedrock varies in texture from sandy to clayey throughout the survey area. The texture and mineral content of soil throughout the survey area is influenced by the kinds of bedrock from which the parent material weathered. The Cheadle soil is an example of a noncalcareous, loamy soil that formed in place in material weathered from igneous rock.

The Passcreek soils formed in place from silty, strongly calcareous residuum derived from silty, strongly calcareous sedimentary rock. The Abor soil is a clayey soil that formed in clayey shale.

Many kinds of parent material have been mixed in alluvium, and the soils that form in them generally are loamy. The Mussel soils, for example, formed in transported alluvium that is mainly loam. The Chinook soils formed in sandy loam alluvium. The Brocko soils formed in wind-laid silt loam.

The size and shape of rock fragments in soils are determined to a large extent by the distance they have been transported by water. Soils on fans close to the mountains are dominated by large, angular and subangular rock fragments. Soils that have moved a long distance downstream are dominated by small, rounded rock fragments. The Rooset soil formed in parent material that was not moved far from its original source. The parent material of the Rivra soils was transported by water a long distance downstream and has well-rounded gravel and cobbles.

Most of the parent material of soils in the survey area has a high content of lime.

Relief

Relief affects the formation of soils by modifying the effect of climate and vegetation in relatively small areas. Relief affects exposure to sun and wind, soil moisture, soil temperature, the rate of erosion, and the kinds and amount of plant and animal life in and on the soil. Certain features of relief, such as degree of slope or shape of the surface, together with soil permeability, control the movement of water on the surface and through the soil.

Where the slopes are steep or runoff is rapid, the soil material is removed by erosion almost as fast as it is formed. As a result, the soils are shallow over bedrock and do not have clearly expressed horizons. The Cabbart soils are this kind of soil.

Soil material is not moved so rapidly on the smoothly sloping or rolling uplands. It is left undisturbed long enough to permit soils to form genetic horizons, such as those in the Abor and Passcreek soils.

Where water has deposited material that formed fans, terraces, and flood plains, the surface is smooth and plane. Less water runs off these areas than off steeper ones, and moisture penetrates deeper into the soil and carries with it soluble salts and lime. The increase in moisture encourages more rapid growth of living organisms and acts as a catalyst for more intensive weathering. Martinsdale, Bridger, and Sappington soils are examples of soils that formed in such areas.

Plant and animal life

Plants, micro-organisms, earthworms, animals, and other forms of life on or in the soils are active in the formation of the soils. Living organisms help to decompose plant residue and to convert nutrients into a form that is more readily available to plants. Living organisms also affect the rate of chemical changes in soils. The amounts and kinds of organisms that live naturally in any given soil are determined by the other interacting factors of soil formation, for example, climate. Burrowing animals, such as moles, influence the formation of soils by mixing the upper layers.

More than 90 percent of this survey area originally was covered by grass. Presently, the only sizable areas of trees are high in the foothills and in the mountains.

Grasses lessen the leaching of the basic elements in the soil by recycling them. The depth to which moisture penetrates is determined partly by grass roots, but mostly by the kind of soil material and the amount and distribution of precipitation. The organic matter produced by the decomposed roots and leaves of plants helps in forming a granular structure in the surface layer. In this way it can either increase the water infiltration rate in clayey soils or increase the available water capacity of sandy soils.

Trees grow in areas where rainfall is higher than in grasslands, or where there is adequate moisture in the soil at depths greater than those generally reached by grass roots.

Climate

Climate is important in the formation of soils because it influences the weathering of minerals. It includes temperature, precipitation, intensity and time of storms, proportion of precipitation that occurs as snow, number of frost-free days, and length of growing season. Weathering is more rapid under a warm, humid climate than under a cold or a dry one. The type and abundance of vegetation are influenced by the amount and frequency of precipitation and by the length of the growing season. Precipitation also affects the translocation and leaching of soluble materials that are a part of the parent material. The more soluble salts move down through the soil first. Lime is the least soluble and is the last to be moved. In the drier parts of the Broadwater County Area, the layer of lime accumulation is usually higher in the profile than it is in the wetter parts. The depth of the maximum concentration of lime is a clue to the average depth of wetting during normal

precipitation.

In the Broadwater County Area, the annual precipitation is mostly 10 to 19 inches; however, there are some areas that receive less than 10 inches and some areas near the mountains that receive more than 19 inches.

Amesha and Musselshell soils are in the 10- to 14-inch precipitation zone, and Martinsdale and Bridger soils are in the 15- to 19-inch precipitation zone.

For more information about temperature and precipitation, refer to the section "Climate" under "General Nature of the Area."

Time

A long time generally is required for soil formation. The differences in length of time that parent material has been in place, therefore, are commonly reflected in the character of the soil. Soils are defined in relative terms, such as "young" and "mature." Properties used to establish the relative age of a soil are thickness of the A1 horizon, content of organic matter, depth of leaching of soluble salts, and the form and distribution of calcium carbonate and gypsum. The accumulation and orientation of clay particles in the subsoil, the degree of weathering, and the kind and grade of structure also give an indication of the age of soils.

Havre loam on a low terrace or flood plain has little organic matter in the surface layer, no clay accumulation, and little translocation of carbonates and is considered a young soil. An Amesha soil that is similar in texture but that is on the second terrace level and has more accumulation and segregation of lime in the subsoil is considered to be an older soil than the Havre loam.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories that are used in detailed soil surveys allow us to organize and apply knowledge about the soils in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparisons in large areas, such as countries and continents.

The system of soil classification currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study; therefore, readers interested in developments of the current system should search the latest literature available.[9] In table 6, the soil series of the Broadwater County Area are placed in categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that soils of similar genesis, or mode of origin, are grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate among these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 6 shows the six soil orders in the Broadwater County Area: Entisols, Inceptisols, Aridisols, Mollisols, Alfisols, and Histosols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Inceptisols are mineral soils that occur on young but not recent land surfaces. They most commonly have a light-colored surface layer and a weakly developed subsoil. They have lost bases or iron and aluminum but retain some weatherable minerals. They occur in a wetter climate than Aridisols.

Aridisols are light-colored soils that are high in bases and that have well-expressed mineral genetic horizons.

Mollisols formed under grass and have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike Mollisols, they do not have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations, but the base status of the lower horizons is not extremely low.

Histosols are dominantly organic. They are mostly soils that are commonly called bogs, or they are peats and mucks. Most are saturated or nearly saturated most of the year unless they have been drained.

SUBORDER.—Each order has been divided into suborders, mainly on the basis of those characteristics that seemed to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences that result from the climate or vegetation.

GREAT GROUP.—Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 6, because it is the last word in the name of the subgroup.

[9] United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and in September 1968]

TABLE 6.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Abor	Fine, montmorillonitic	Borollic Vertic Camborthids	Aridisols.
Amesha	Coarse-loamy, mixed	Borollic Calciorthids	Aridisols.
Blaine	Loamy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Blanyon	Fine, montmorillonitic	Borollic Vertic Haplargids	Aridisols.
Bridger	Fine, mixed	Argic Cryoborolls	Mollisols.
Brocko	Coarse-silty, mixed	Borollic Calciorthids	Aridisols.
Cabbart	Loamy, mixed (calcareous), frigid, shallow.	Ustic Torriorthents	Entisols.
Cheadle	Loamy-skeletal, mixed	Lithic Cryoborolls	Mollisols.
Chinook	Coarse-loamy, mixed	Aridic Haploborolls	Mollisols.
Chinook variant	Coarse-loamy over sandy or sandy-skeletal, mixed.	Aridic Haploborolls	Mollisols.
Crago	Loamy-skeletal, carbonatic	Borollic Calciorthids	Aridisols.
Delphill	Fine-loamy, mixed (calcareous), frigid	Ustic Torriorthents	Entisols.
Dominic	Sandy-skeletal, mixed	Typic Haploborolls	Mollisols.
Ess	Loamy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Fairdale	Fine-loamy, mixed	Fluvquentic Haploborolls	Mollisols.
Havre	Fine-loamy, mixed (calcareous), frigid	Ustic Torrifluvents	Entisols.
Hilger	Clayey-skeletal, mixed	Typic Argiborolls	Mollisols.
Lake Creek	Loamy-skeletal, mixed	Typic Cryoboralfs	Alfisols.
Loberg	Clayey-skeletal, mixed	Typic Cryoboralfs	Alfisols.
Lothair	Fine, mixed (calcareous), frigid	Ustic Torriorthents	Entisols.
Martinsdale	Fine-loamy, mixed	Typic Argiborolls	Mollisols.
Mussel	Fine-loamy, mixed (calcareous), frigid	Ustic Torriorthents	Entisols.
Musselshell	Coarse-loamy, carbonatic	Borollic Calciorthids	Aridisols.
Nielsen	Loamy-skeletal, mixed	Argic Lithic Cryoborolls	Mollisols.
Passcreek	Fine-loamy, mixed	Argic Cryoborolls	Mollisols.
Perma	Loamy-skeletal, mixed	Typic Haploborolls	Mollisols.
Radersburg	Clayey-skeletal, mixed	Aridic Argiborolls	Mollisols.
Rencot	Loamy-skeletal, mixed	Lithic Borollic Calciorthids	Aridisols.
Rivra	Sandy-skeletal, mixed, frigid	Ustic Torrifluvents	Entisols.
Rooset	Clayey-skeletal, montmorillonitic	Argic Cryoborolls	Mollisols.
Rootel	Fine-loamy, mixed	Borollic Calciorthids	Aridisols.
Sappington	Coarse-loamy, mixed	Aridic Argiborolls	Mollisols.
Scravo	Sandy-skeletal, mixed	Borollic Calciorthids	Aridisols.
Thess	Fine-loamy over sandy or sandy-skeletal, mixed.	Borollic Calciorthids	Aridisols.
Tolman	Loamy-skeletal, mixed	Lithic Argiborolls	Mollisols.
Toston	Fine-loamy, mixed, frigid	Aquic Natrargids	Aridisols.
Tropal	Loamy-skeletal, carbonatic	Lithic Cryochrepts	Inceptisols.
Villy	Fine-silty, mixed (calcareous), frigid	Typic Fluvaquents	Entisols.
Whitore	Loamy-skeletal, carbonatic	Typic Cryochrepts	Inceptisols.
Windham	Loamy-skeletal, carbonatic	Typic Calciborolls	Mollisols.
Woodrock	Fine-loamy, mixed	Typic Cryboralfs	Alfisols.

SUBGROUP.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives in front of the great group.

FAMILY.—Families are established within a subgroup mainly on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

General Nature of the Area

This section describes the physiography, relief, drainage, climate, farming, mining, transportation, and other subjects of general interest in the survey area.

Members of the Lewis and Clark Expedition recorded their passage through the area that is now Broadwater County on July 21, 1805. At this time and for many years after, the Broadwater County Basin was a hunting ground for the Crow, Blackfeet, and other Indian tribes.

After the departure of this expedition, nothing of recorded historic importance occurred in the county for nearly 60 years. During the winter of 1864-65, gold was discovered in Confederate Creek. During the next 33 years many people migrated to the Broadwater County Area, mainly because of gold mining.

Broadwater County was formed in 1897 by an act of the State legislature. It was formed from parts of both Meagher and Jefferson Counties. Townsend, the county seat, is in the central part of the county about 35 miles southeast of Helena, the State capital. With the building of the railroad in 1883, the town grew rapidly because of its location in the center of the mining, farming, and stock-raising area. Today Townsend has a population of about 1,500 and is the educational, financial, and social center of the county. Other towns in the county are Toston, Radersburg, Winston, and Lombard.

A boom town now nonexistent in Broadwater County was Diamond City. With the discovery of gold in Con-

federate Gulch in 1864, hundreds of miners thronged to this rich new field. At its peak the population of Diamond City was 2,000 and the total population of the entire gulch was 5,000.

Amateur prospectors who did not know how to discover gold were known as pilgrims. It is said that one of these pilgrims naively asked an oldtimer to suggest where he could do some digging. The older man, in true frontier style, pointed out the most unpromising spot in sight and suggested, "Try that bar up there, you might find something." The novice followed his advice and staked his claim on the Montana bar—placer ground covering less than 2 acres—which proved to be one of the richest spots ever found. Confederate Gulch alone is said to have yielded $12,000,000 in placer gold, and the gulches and river bars to the northwest, partly in Lewis and Clark County, an additional $5,500,000. In addition to the gold produced in the survey area, a considerable amount of silver, copper, and zinc was also mined.

The large influx of people into the mining areas created an increased demand for food and farm produce. It is reported that stockmen drove their herds into the survey area from western Montana and later, after the military forts were constructed, from the plains of Kansas and Texas. During this time stock raising and mining were the chief industries.

The construction of a railway through the Townsend Basin during the early 1880's did not greatly influence farming in the survey area. After mining became less profitable, however, many miners turned to farming and ranching, which later became the principal means of a livelihood in the survey area.

The development of farming in the survey area was slow until about 1906, when various State agencies undertook the development of the farm resources of the State. The more desirable land was homesteaded and fenced in tracts of 160 acres. After passage of the Desert Act in 1913, the size of most tracts to be homesteaded was expanded to 320 acres. Most of the early homesteads put under cultivation between 1908 and 1950 were in the southern part of the county.

At present, most of the income for the Broadwater County Area is derived from the sale of crops and livestock. Slightly more than half of the total income comes from the sale of livestock and livestock products. Irrigation was developed in the Townsend Basin during the 1880's by some of the early stockmen, who constructed small dams in the streams to divert the perennial flow and floodwaters on the meadowlands for the production of wild hay. Most of the irrigation development in the survey area has taken place since 1900. The irrigated land has been a stabilizing factor in assuring feed for livestock and income from the sale of cash crops.

At the present time there is about 40,000 acres of irrigated cropland in the Broadwater County Area. This acreage includes about 9,000 acres serviced by 48 sprinkler systems.

Dry cropland covers about 70,000 acres, and tame pasture, about 10,800 acres. The balance of the land in the Broadwater County Area is in range, with the exception of about 18,000 acres of woodland.

At the present time there is about 32,000 acres of hay crops; 23,500 acres of wheat; 14,000 acres of barley; 1,200 acres of oats; 500 acres of potatoes; and 2,000 acres of sugar beets. In addition, there are small acreages of rye, alfalfa seed, grass and legume seed, and corn. The sugar beets, potatoes, corn, and most of the alfalfa seed produced in the survey area are limited to the irrigated valley lands. These crops provide a cash income and may also be used as a cultivated rotation crop, which is important in the control of weeds. Wheat is produced mostly in the southern end of the county and on the benchlands that border the eastern side of the Missouri River Valley.

The county assessor's office lists 37,000 head of beef cattle and calves, 6,000 sheep, and 2,000 hogs. A facility that will house 120,000 laying hens is being built near Townsend. The pattern of sheep production during the past few years has changed to more farm flock operators and less range sheep operators. There are about 35 farm flock operators of sheep in the Broadwater County Area. Beef cattle of all popular breeds are grown throughout the survey area, and several operators are engaged in quality production of purebred stock.

The Broadwater County Area is served by two major highways. U.S. Highway 287 traverses the county in a south to northwest direction for a distance of about 42 miles. This highway starts at its junction with Interstate 90 near the southern boundary of the county about 3 miles northwest of the town of Three Forks and extends northwest through the towns of Toston, Townsend, and Winston, somewhat parallel to the Missouri River. Interstate 90 enters the county at the Jefferson River and extends west to the Jefferson County boundary. The survey area is also served by Montana State Highway 12, which starts at Townsend and courses east along Deep Creek to the Forest Service boundary about 14 miles east of Townsend, and by two improved, paved county roads. Two railroads, a bus line for mail and freight service only, and a small airport about 2 miles east of Townsend also provide transportation in the survey area. The nearest major airport is at Helena, about 35 miles from Townsend.

Climate [10]

The Broadwater County Area has a modified continental climate. Several factors enter into the modification of continental climate characteristics. The more important of these factors are the frequent invasions of Pacific Ocean air masses, drainage of cool air into the valley from the surrounding mountains, and the protecting mountain shield in all directions, which combine to make temperature changes somewhat smaller than those expected of a true continental climate. Terrain is also an important factor in the pattern of precipitation in the survey area. The surrounding mountains cause a "rain shadow" effect in the valley of the Missouri River. Annual precipitation varies from less than 12 inches on the valley floor to about 40 inches at the higher elevations both east and west of the valley. About three-fourths of the average annual precipitation falls during the 6-month period of April to September. May and June are normally the wettest months.

During the cold season, nearly all precipitation falls as snow. At the lower elevations, snow usually does not remain on the ground for extended periods of time, but in the

[10] By R. A. DIGHTMAN, climatologist for Montana, National Weather Service, U.S. Department of Commerce.

TABLE 7.—*Temperature*

[Data from Townsend, based on

Month	Temperature (°F)				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total
January	31	7	52	-20	0.5
February	38	14	56	-9	.3
March	44	18	64	-6	.5
April	57	28	76	14	.9
May	66	37	84	24	1.8
June	73	44	89	32	2.5
July	84	48	95	38	1.1
August	83	46	95	35	1.1
September	71	38	88	24	1.2
October	60	29	79	16	.7
November	44	20	63	-1	.5
December	36	13	54	-13	.5
Year	57	29	97 [1]	-25 [2]	11.6

[1] Average annual highest temperature. [2] Average annual lowest temperature.

mountains it begins accumulating in November most years, reaching the greatest depth and water content in April or early in May. Infrequently, heavy rain late in May or in June coincides with periods of maximum melting of the mountain snowpack, and this combination causes some degree of flooding in some streams. However, flooding is not a serious hazard in the survey area.

Steady rain may occur at any time of year, but summer precipitation falls mostly in showers. Winter snow tends to be heaviest in December and January, but the water content of the snow is usually low. Snowfall in the higher mountains is estimated to reach a total of about 200 inches annually. The yearly snowfall is only approximately 30 inches on the valley floor.

During winter there usually are a few invasions of very cold Arctic air which drop temperatures to well below zero. Such extreme cold usually lasts only a few days, but extended cold spells do occur occasionally. Snow and blowing snow sometimes accompany the cold air invasions, but this type of storm usually lasts only a day or two. Mild weather is common during winter, and the temperature is above freezing on the valley floor. Such mild weather is less common in the area of Townsend than along the east slopes of the Rocky Mountains.

Temperature in summer is moderate, and the maximum reading is generally less than 90° F and very seldom reaches 100°. There is usually a marked change in temperature from day to night, which tends to produce an agreeable combination of fairly warm days and cool nights during summer. The growing season averages 103 days at Townsend, but the freeze-free season is shorter at the higher elevations.

Thunderstorms are frequent from May to August, and the maximum occurrence is in July. Only seldom is there a damaging hailstorm or a severe ice or sleet storm in winter. Strong winds can occur at any time throughout the year, but generally do not last more than a few hours at a time.

Tables 7, 8, 9, and 10 are summaries of various data from the Broadwater County Area climate records.

TABLE 8.—*Average precipitation in inches*

[Length of record: at the station 12 miles ENE. of Townsend, 30 years; at the station 3 miles SW. of Toston, 13 years]

Month	Townsend 12ENE	Toston 3SW
January	1.0	0.4
February	.8	.3
March	1.1	.7
April	1.4	1.0
May	2.3	1.8
June	3.0	2.7
July	1.2	1.1
August	1.3	1.1
September	1.4	1.0
October	1.1	.7
November	1.0	.6
December	1.0	.4
Year	16.6	11.8

TABLE 9.—*Average snowfall in inches*

Month	Townsend	Toston 3SW
January	6.6	6.0
February	4.1	3.5
March	4.2	4.6
April	1.7	3.6
May	1.0	0.2
June	(1)	0.2
July	0	0
August	0	0
September	0.3	0.4
October	0.8	1.2
November	4.1	3.0
December	5.7	7.3
Year	28.5	30.0

[1] Trace.

and precipitation data

period 1942-70; elevation 3,833 feet]

Precipitation (inches)							
1 year in 10 will have—		2 years in 10 will have—		3 years in 10 will have—		4 years in 10 will have—	
Less than—	More than—	Less than—	More than—	Less than—	More than—	Less than—	More than—
0.1	1.0	0.2	0.7	0.3	0.6	0.4	0.5
.1	.5	.1	.4	.2	.3	.2	.3
.2	.9	.3	.7	.4	.5	.4	.5
.5	1.4	.6	1.2	.7	1.0	.7	.8
.9	2.6	1.1	2.4	1.5	2.2	1.7	1.9
.9	4.2	1.7	3.3	1.9	2.9	2.1	2.4
.3	2.0	.6	1.5	.7	1.3	.8	1.0
.4	2.1	.6	1.5	.7	1.1	.8	1.0
.2	2.9	.3	2.0	.4	1.4	.7	1.0
.1	1.3	.3	1.1	.4	1.0	.5	.8
.2	.8	.3	.7	.3	.5	.4	.5
.1	1.0	.2	.8	.2	.5	.3	.4
8.2	15.5	9.1	13.7	9.6	12.5	10.3	11.9

Relief and Drainage

Most of the Broadwater County Area covers an intermountain basin, known as the Townsend Basin, that lies between the Big Belt and Elkhorn Mountains.

Geologists think that this intermountain basin was an inland lake formed during the Oligocene Epoch. The water accumulated behind the mountain uplift before the Missouri River cut its present channel through the mountains to the north. The lake covered the basin to a great depth, and sediment was deposited over its entire area, including the lower slopes of the present mountains and stream divides at elevations of 4,600 to 4,800 feet. The Missouri River flows north through this basin.

The survey area is about 55 miles long and mostly 18 to 20 miles wide. The surface features are the result of volcanic and dynamic forces that produced the mountain ranges during the Cretaceous and Tertiary periods. Topographic features were altered by subsequent erosion and deposition of colluvial-alluvial material on the mountain slopes and in the intermountain valleys.

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

Probability	Dates for given probability and temperature		
	24° F or lower	28° F or lower	32° F or lower
Spring:			
1 year in 10 later than	May 12	May 25	June 17
2 years in 10 later than	May 8	May 20	June 11
5 years in 10 later than	April 29	May 10	May 29
Fall:			
1 year in 10 earlier than	September 16	September 4	August 25
2 years in 10 earlier than	September 22	September 10	August 30
5 years in 10 earlier than	October 4	September 22	September 9

The major landforms within the survey area are mountains, hills, fans, tablelands, benchlands, rolling land, narrow stream valleys, and the Townsend Basin.

Mountainous areas are mostly that part of the Big Belt and Elkhorn Mountains that lies within the survey area below the Forest Service boundary. The major hilly areas are the Spokane hills in the northern part of the survey area, the Limestone hills between Townsend and Radersburg, and the Limestone Ridge hills between Toston and Three Forks. The high points within these hilly areas are about 6,000 feet above sea level.

The higher gravel-capped tablelands are on the western slopes of the Big Belt Mountains in the east-central part of the survey area. They range in elevation from 4,600 to 5,000 feet. Similar tablelands are on the slopes of the Elkhorn Mountains in the vicinity of Radersburg. Their protective covering, which overlies lakebed sediment at varying depths on the lower part of the tablelands, consists largely of stony and gravelly outwash from the mountains. The surface topography consists of long, smooth, single slopes and rolling or convex relief. They are mostly moderately sloping and are dissected by entrenched streams.

Benchlands, occupying lower erosional levels and probably of Pleistocene age, border the Missouri River Valley on the east between Toston and Canyon Ferry. These benchlands are separated by intervening stream valleys at elevations of 3,600 to 4,200 feet. They have a smooth surface and gradients of 30 to 40 feet to the mile, and they are 25 to 50 feet above the level of the streams. Their protective covering north of Confederate Creek is mainly limestone and argillitic and quartzitic gravel that grades into stratified sand and gravel near the river valley. The benchlands between Confederate and Duck Creeks occupy different erosional levels, and in places they grade into each other without distinct contours. The higher levels have been modified by soil blowing, and their surface is undulating to rolling. The smooth, gently sloping benchlands along the Missouri River Valley south of Dry Creek are mainly silt.

Coalescing colluvial-alluvial fans form the steeply sloping, stony benches below the Elkhorn Mountains, north of Crow Creek and west of the Missouri River. They contain

angular fragments of igneous and metamorphosed rock and rounded gravel. The benches between Indian and Beaver Creeks lie between elevations of 3,800 and 4,200 feet, and their protective covering is mainly limestone, argillite, and quartzite stone fragments and gravel. Gradients are 30 to 60 feet to the mile. These benches are 25 feet or more above the level of the coulee beds. The protective covering on the more gently sloping benches along Beaver Creek and its branches is mainly stony material, probably derived from glacial outwash. The high bench that rises above the Missouri River Valley south of Beaver Creek is covered with subangular fragments of igneous and metamorphic rock that are underlain by lakebed sediments at varying depths.

The intermountain basin in the southern part of the survey area west of the limestone ridge hills and south of Crow Creek has an elevation of 4,000 to 5,000 feet. This part of the basin has an undulating to gently rolling topography, and it slopes gently to the north into a poorly drained area south of Crow Creek. The surface material is mainly reworked lakebed sediment. Low benchlands of silt material, similar in character to those east of the Missouri River Valley and south of Dry Creek, border the small valley of Spring Creek and the swampy tract on the west, south of Crow Creek. Several small benches, capped chiefly with limestone gravel, occupy higher levels south of Radersburg.

Other benches occur along the Jefferson and Missouri River Valleys in the southern part of the survey area. Most of these benches or high terraces are composed of stratified silt and fine sand. The higher terraces in the Missouri River Valley in the central part of the survey area are commonly very stony.

Missouri River Drainage Basin

All the larger streams in the Broadwater County Area empty directly into the Missouri River or into Canyon Ferry Lake. A few intermittent streams rise on the Boulder-Missouri River Divide and flow west to the Boulder River and south into the Jefferson River. The Missouri River and its tributaries are at flood stage during spring runoff, usually in March, early in April, in May and June, and again when they are swollen by seasonal rainfall and by melting snow. Most of the smaller streams have a continuous flow in the mountains but an intermittent flow in the intermountain basin. The larger streams that unite with the Missouri River or Canyon Ferry Lake from the east are Hellgate, Avalanche, and White Gulches and Confederate, Duck, Gurnet, Cottonwood, Deep, Grayson, Dry, and Six Mile Creeks; those from the west are Beaver, Indian, and Crow Creeks. Spring Creek is a perennial branch of Crow Creek.

Glossary

AC soil. A soil that has an A horizon and a C horizon but no B horizon. Such soils are immature. They commonly formed in alluvium or colluvium on steep, rocky slopes.

Aggregate, soil. Soil particles held in a single mass or cluster. Natural soil aggregates such as granules, blocks, or prisms are called peds. Aggregates produced by tillage are called clods.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alkaline soil. Generally, a soil that is alkaline throughout most or all of the parts occupied by plant roots, although the term is commonly applied to only a specific layer or horizon of a soil. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3

Alluvial soil. A soil that has developed in material transported and deposited by streams and has been modified only slightly if at all by soil-forming processes.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of a soil to store water available for use by plants. The available water capacity is expressed thus:

very low	0 to 3 inches
low	3 to 6 inches
moderate	6 to 9 inches
high	9 inches or more

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Decreaser. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Depth, effective soil. The depth of soil material that plant roots can penetrate readily to obtain water and plant nutrients. It is the depth to a layer that differs sufficiently from the overlying material in physical or chemical properties to prevent or seriously retard the root growth of plants. Depth is expressed thus:

Very shallow	less than 10 inches
Shallow	10 to 20 inches.
Moderately deep	20 to 40 inches
Deep	40 inches or more

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide nutrients, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Fertilizer. Any material put on or in the soil to supply elements essential for plant growth, such as manure, chemicals, or crop residue.

Field moisture capacity. The amount of soil water remaining in a soil after the free water has been allowed to drain away for a day or two if the root zone has been previously saturated. It is the greatest amount of water that a soil will hold under conditions of free drainage. It generally is expressed as a percentage of the oven-dry weight of soil.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. The major horizons are:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon generally below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Illuviation. The process of deposition of clay, humus, or salts removed from one horizon to another in the soil, usually from the upper to a lower horizon in the soil profile.

Krotovinas. Irregular tubular streaks of material transported from another soil horizon. Caused when the tunnels made by burrowing animals are filled with material from outside the horizon.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt and less than 52 percent sand.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottled. Soil irregularly marked with spots of color. Mottling in soils usually indicates poor aeration and impeded drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* Size measurements are: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Organic soil. A soil that contains a high percentage (more than 20 percent by weight) of organic matter.

Parent material. The unconsolidated, chemically weathered mineral or organic matter from which a soil has formed by pedogenic processes.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, generally expressed in pH value. A soil that tests to pH 7.0 is neutral in reaction because it is neither acid nor alkaline. An acid soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher.

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A nonalkali soil that contains sufficient soluble salts to impair its productivity but does not contain excess exchangeable sodium.

Saline-alkali soil. A soil that has a combination of harmful quantities of salts and either a high alkalinity or high exchangeable sodium or both so distributed in the profile that the growth of most plants is reduced.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Site index. A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Slope. The incline of the soil surface, generally expressed as the number of feet of fall per 100 feet of horizontal distance.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. The B horizon of soils that have distinct profiles.

Substratum. Technically, the part of the soil below the solum.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

☆ U. S. GOVERNMENT PRINTING OFFICE : 1977--228-700/39

Guide to Mapping Units

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. In referring to a capability unit, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. Absence of data in a capability unit, a range site, or a windbreak suitability group column indicates the soil was not placed in that interpretative group.

Map symbol	Mapping unit	Page	Dryland capability unit	Irrigated capability unit	Range site	Windbreak suitability group
			Symbol	Symbol	Name	
AbC	Abor silty clay, 3 to 9 percent slopes	7	IIIe-4	------	Clayey, 10-14 inch precipitation zone	3M
Af	Aeric Fluvaquents	7	VIw-1	------	Subirrigated, 10-14 inch precipitation zone	2W
AmB	Amesha sandy loam, 1 to 4 percent slopes	8	IIIe-2	IIe-1	Sandy, 10-14 inch precipitation zone	3L
AmC	Amesha sandy loam, 4 to 9 percent slopes	8	IIIe-4	IIIe-1	Sandy, 10-14 inch precipitation zone	3L
AnB	Amesha cobbly sandy loam, 1 to 4 percent slopes	8	IIIe-2	IIe-1	Sandy, 10-14 inch precipitation zone	3L
AoB	Amesha loam, 1 to 4 percent slopes	8	IIIe-2	IIe-1	Limy, 10-14 inch precipitation zone	3L
AoC	Amesha loam, 4 to 9 percent slopes	9	IIIe-4	IIIe-1	Limy, 10-14 inch precipitation zone	3L
BcE	Blaine-Cheadle complex, 10 to 25 percent slopes	9	VIe-1	------	----------	4
	Blaine cobbly loam	--	------	------	Silty, 15-19 inch precipitation zone	--
	Cheadle cobbly loam	--	------	------	Shallow, 15-19 inch precipitation zone	--
BdC	Blanyon clay loam, 3 to 10 percent slopes	10	IIIe-4	------	Clayey, 10-14 inch precipitation zone	2M
Bo	Borohemists	10	VIw-1	------	Wetland, 10-19 inch precipitation zone	--
BpD	Bridger cobbly loam, 5 to 15 percent slopes	10	IVe-2	IVe-1	Silty, 15-19 inch precipitation zone	2M
BrD	Bridger silt loam, 5 to 15 percent slopes	11	IVe-2	IVe-1	Silty, 15-19 inch precipitation zone	2M
BsA	Brocko silt loam, 0 to 2 percent slopes	11	IIIe-2	IIc-1	Silty, 10-14 inch precipitation zone	3L
BsB	Brocko silt loam, 2 to 5 percent slopes	11	IIIe-2	IIe-1	Silty, 10-14 inch precipitation zone	3L
BsC	Brocko silt loam, 5 to 9 percent slopes	11	IIIe-4	IIIe-1	Silty, 10-14 inch precipitation zone	3L
BsD	Brocko silt loam, 9 to 25 percent slopes	11	VIe-1	------	Silty, 10-14 inch precipitation zone	4
BtA	Brocko silt loam, wet, 0 to 2 percent slopes	12	------	IIIw-1	Subirrigated, 10-14 inch precipitation zone	2W
CaE	Cabbart complex, 9 to 35 percent slopes	12	VIIe-1	------	Thin Breaks, 10-14 inch precipitation zone	4
CdE	Cheadle stony loam, 9 to 35 percent slopes	13	VIe-1	------	Shallow, 15-19 inch precipitation zone	4
ChB	Chinook sandy loam, 1 to 4 percent slopes	13	IIIe-2	IIe-1	Sandy, 10-14 inch precipitation zone	2M

Map symbol	Mapping unit	Page	Dryland capability unit Symbol	Irrigated capability unit Symbol	Range site Name	Windbreak suitability group
ChC	Chinook sandy loam, 4 to 9 percent slopes------	13	IIIe-4	IIIe-1	Sandy, 10-14 inch precipitation zone	2M
CkB	Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes----------	14	IVs-2	IIIe-3	Sandy, 10-14 inch precipitation zone	3M
CmC	Chinook-Crago loamy sands, 1 to 9 percent slopes----------	13	VIe-1	IIIe-3	Sands, 10-14 inch precipitation zone	--
	Chinook loamy sand----------	--	------	------	----------	2M
	Crago loamy sand----------	--	------	------	----------	3M
CnC	Chinook-Crago complex, 5 to 9 percent slopes---	13	IIIe-4	IIIe-3	----------	--
	Chinook sandy loam----------	--	------	------	Sandy, 10-14 inch precipitation zone	2M
	Crago cobbly sandy loam----------	--	------	------	Limy, 10-14 inch precipitation zone	3M
CnE	Chinook-Crago complex, 9 to 35 percent slopes--	14	VIe-1	------	----------	4
	Chinook sandy loam----------	--	------	------	Sandy, 10-14 inch precipitation zone	--
	Crago cobbly sandy loam----------	--	------	------	Limy, 10-14 inch precipitation zone	--
CrC	Crago complex, 4 to 9 percent slopes----------	15	IVs-2	IIIe-3	Limy, 10-14 inch precipitation zone	3M
DeB	Delphill loam, 2 to 5 percent slopes----------	15	IIIe-2	------	Silty, 10-14 inch precipitation zone	2M
DhD	Delphill-Abor complex, 5 to 20 percent slopes--	15	VIe-1	------	----------	--
	Delphill loam----------	--	------	------	Silty, 10-14 inch precipitation zone	2M
	Abor silty clay----------	--	------	------	Clayey, 10-14 inch precipitation zone	3M
Do	Dominic soils----------	16	VIs-1	------	Shallow to Gravel, 10-14 inch precipitation zone	4
EcF	Ess-Cheadle complex, 35 to 60 percent slopes---	17	VIe-1	------	----------	4
	Ess very stony loam----------	--	------	------	Stony, 15-19 inch precipitation zone	--
	Cheadle stony loam----------	--	------	------	Shallow, 15-19 inch precipitation zone	--
Fa	Fairdale silt loam----------	17	------	IIIw-1	Subirrigated, 10-14 inch precipitation zone	2W
Fb	Fairdale-Lothair silty clays----------	17	------	IIIw-1	Subirrigated, 10-14 inch precipitation zone	2W
Fd	Fluvaquentic Haplaquolls----------	18	VIw-1	------	Wetland, 10-19 inch precipitation zone	4
Ha	Havre loam----------	18	IIIe-2	IIc-1	Silty, 10-14 inch precipitation zone	2M
HgE	Hilger extremely stony loam, 8 to 25 percent slopes----------	19	VIs-1	------	Stony, 15-19 inch precipitation zone	4
LaF	Lake Creek channery loam, 20 to 50 percent slopes----------	19	VIe-1	------	----------	--
LoE	Loberg very stony loam, 10 to 35 percent slopes----------	20	VIe-1	------	----------	--
Lt	Lothair silty clay----------	20	------	IIs-1	Clayey, 10-14 inch precipitation zone	2M

Map symbol	Mapping unit	Page	Dryland capability unit Symbol	Irrigated capability unit Symbol	Range site Name	Windbreak suitability group
MaB	Martinsdale loam, 2 to 5 percent slopes--------	21	IIIe-6	IIIe-5	Silty, 15-19 inch precipitation zone	2L
MaC	Martinsdale loam, 5 to 9 percent slopes--------	21	IIIe-6	IIIe-5	Silty, 15-19 inch precipitation zone	2L
McC	Martinsdale cobbly loam, 2 to 9 percent slopes----------	21	IIIe-6	IIIe-5	Silty, 15-19 inch precipitation zone	2L
Md	Mine dumps----------	21	VIII	------	----------	--
MsA	Mussel loam, 0 to 2 percent slopes----------	22	IIIe-2	IIc-1	Silty, 10-14 inch precipitation zone	2M
MsB	Mussel loam, 2 to 5 percent slopes----------	22	IIIe-2	IIe-1	Silty, 10-14 inch precipitation zone	2M
Mt	Mussel-Crago complex----------	22	IIIe-2	IIe-1	----------	--
	Mussel loam----------	--	------	------	Silty, 10-14 inch precipitation zone	2M
	Crago cobbly loam----------	--	------	------	Limy, 10-14 inch precipitation zone	3M
MuB	Mussel-Musselshell complex, 2 to 5 percent slopes----------	22	IIIe-2	IIe-1	----------	--
	Mussel loam----------	--	------	------	Silty, 10-14 inch precipitation zone	2M
	Musselshell loam----------	--	------	------	Limy, 10-14 inch precipitation zone	3L
MuC	Mussel-Musselshell complex, 5 to 9 percent slopes----------	22	IIIe-4	IIIe-1	----------	--
	Mussel loam----------	--	------	------	Silty, 10-14 inch precipitation zone	2M
	Musselshell loam----------	--	------	------	Limy, 10-14 inch precipitation zone	3L
MvB	Musselshell gravelly loam, 2 to 5 percent slopes----------	23	IIIe-2	IIe-1	Limy, 10-14 inch precipitation zone	3L
MvC	Musselshell gravelly loam, 5 to 9 percent slopes----------	23	IIIe-4	IIIe-1	Limy, 10-14 inch precipitation zone	3L
MwE	Musselshell-Crago channery loams, 15 to 35 percent slopes----------	23	VIe-1	------	Limy, 10-14 inch precipitation zone	4
MxE	Musselshell-Crago cobbly loams, 8 to 20 percent slopes----------	23	VIe-1	------	Limy, 10-14 inch precipitation zone	--
	Musselshell cobbly loam----------	--	------	------	----------	3L
	Crago cobbly loam----------	--	------	------	----------	3M
MyC	Musselshell-Thess cobbly loams, 3 to 8 percent slopes----------	23	IIIe-4	IIIe-1	Limy, 10-14 inch precipitation zone	3L
NeF	Neilsen channery loam, 15 to 60 percent slopes----------	24	VIe-1	------	Shallow, 15-19 inch precipitation zone	4
PaD	Passcreek channery silt loam, 6 to 15 percent slopes----------	25	IVe-2	------	Silty, 15-19 inch precipitation zone	3M

Map symbol	Mapping unit	Page	Dryland capability unit	Irrigated capability unit	Range site	Windbreak suitability group
			Symbol	Symbol	Name	
PcE	Passcreek-Lake Creek channery loams, 15 to 35 percent slopes	25	VIe-1	------	----------	--
	Passcreek channery loam	--	------	------	Silty, 15-19 inch precipitation zone	4
	Lake Creek channery loam	--	------	------	----------	--
Pm	Perma very cobbly loam	25	VIs-1	------	Stony, 15-19 inch precipitation zone	3M
Pr	Perma very cobbly loam, wet	26	VIw-1	------	Subirrigated, 10-14 inch precipitation zone	2W
Ra	Radersburg very cobbly loam	26	VIs-1	------	Stony, 10-14 inch precipitation zone	3M
ReE	Rencot channery loam, 15 to 35 percent slopes	26	VIe-1	------	Shallow, 10-14 inch precipitation zone	4
Rr	Rivra gravelly loam	27	VIs-1	------	Overflow, 10-14 inch precipitation zone	4
RsE	Rooset extremely stony loam, 9 to 35 percent slopes	28	VIs-1	------	Stony, 15-19 inch precipitation zone	4
RtC	Rootel channery loam, 3 to 9 percent slopes	28	IIIe-4	------	Limy, 10-14 inch precipitation zone	3M
SaB	Sappington clay loam, 2 to 5 percent slopes	29	IIIe-2	IIe-1	Silty, 10-14 inch precipitation zone	3L
SaC	Sappington clay loam, 5 to 9 percent slopes	29	IIIe-4	IIIe-1	Silty, 10-14 inch precipitation zone	3L
SgB	Sappington gravelly clay loam, 2 to 5 percent slopes	29	IIIe-2	IIe-1	Silty, 10-14 inch precipitation zone	3L
SgC	Sappington gravelly clay loam, 5 to 9 percent slopes	29	IIIe-4	IIIe-1	Silty, 10-14 inch precipitation zone	3L
Sv	Scravo cobbly loam	29	VIs-1	IVs-1	Shallow to Gravel, 10-14 inch precipitation zone	3M
Sw	Scravo very cobbly loam	30	VIs-1	------	Shallow to Gravel, 10-14 inch precipitation zone	3M
Te	Thess silt loam	30	IIIe-2	IIe-1	Limy, 10-14 inch precipitation zone	3L
Ts	Thess-Scravo complex	30	IVs-2	IIIs-1	----------	--
	Thess loam	--	------	------	Limy, 10-14 inch precipitation zone	3L
	Scravo cobbly loam	--	------	------	Shallow to Gravel, 10-14 inch precipitation zone	3M
TtE	Tolman channery loam, 10 to 35 percent slopes	31	VIe-1	------	Shallow, 10-14 inch precipitation zone	4
Tu	Toston silty clay loam	31	VIw-1	------	Saline Lowland, 10-14 inch precipitation zone	4
TvF	Tropal-Rock outcrop complex, 15 to 60 percent slopes	32	VIIe-1	------	----------	--
	Tropal stony loam	--	------	------	Very Shallow, 10-19 inch precipitation zone	4
	Rock outcrop	--	------	------	----------	--

Map symbol	Mapping unit	Page	Dryland capability unit	Irrigated capability unit	Range site	Windbreak suitability group
			Symbol	Symbol	Name	
Uf	Ustic Torrifluvents	32	VIw-1	------	Overflow, 10-14 inch precipitation zone	2W
Ut	Ustic Torriorthents, saline	32	VIw-1	------	Saline Lowland, 10-14 inch precipitation zone	4
Va	Villy silty clay loam	33	VIw-1	------	Wetland, 10-19 inch precipitation zone	4
Vd	Villy silty clay loam, drained	33	------	IIIw-1	Subirrigated, 10-14 inch precipitation zone	2W
WhF	Whitore channery silt loam, 25 to 60 percent slopes	33	VIe-1	------	----------	--
WnE	Windham cobbly loam, 9 to 35 percent slopes	34	VIe-1	------	Silty, 15-19 inch precipitation zone	4
WoF	Woodrock-Loberg complex, 15 to 60 percent slopes	34	VIe-1	------	----------	--
WrE	Woodrock-Rock outcrop complex, 15 to 35 percent slopes	35	VIe-1	------	----------	--

Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The USDA Target Center can convert USDA information and documents into alternative formats, including Braille, large print, video description, diskette, and audiotape. For more information, visit the TARGET Center's Web site (http://www.targetcenter.dm.usda.gov/) or call (202) 720-2600 (Voice/TTY).

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

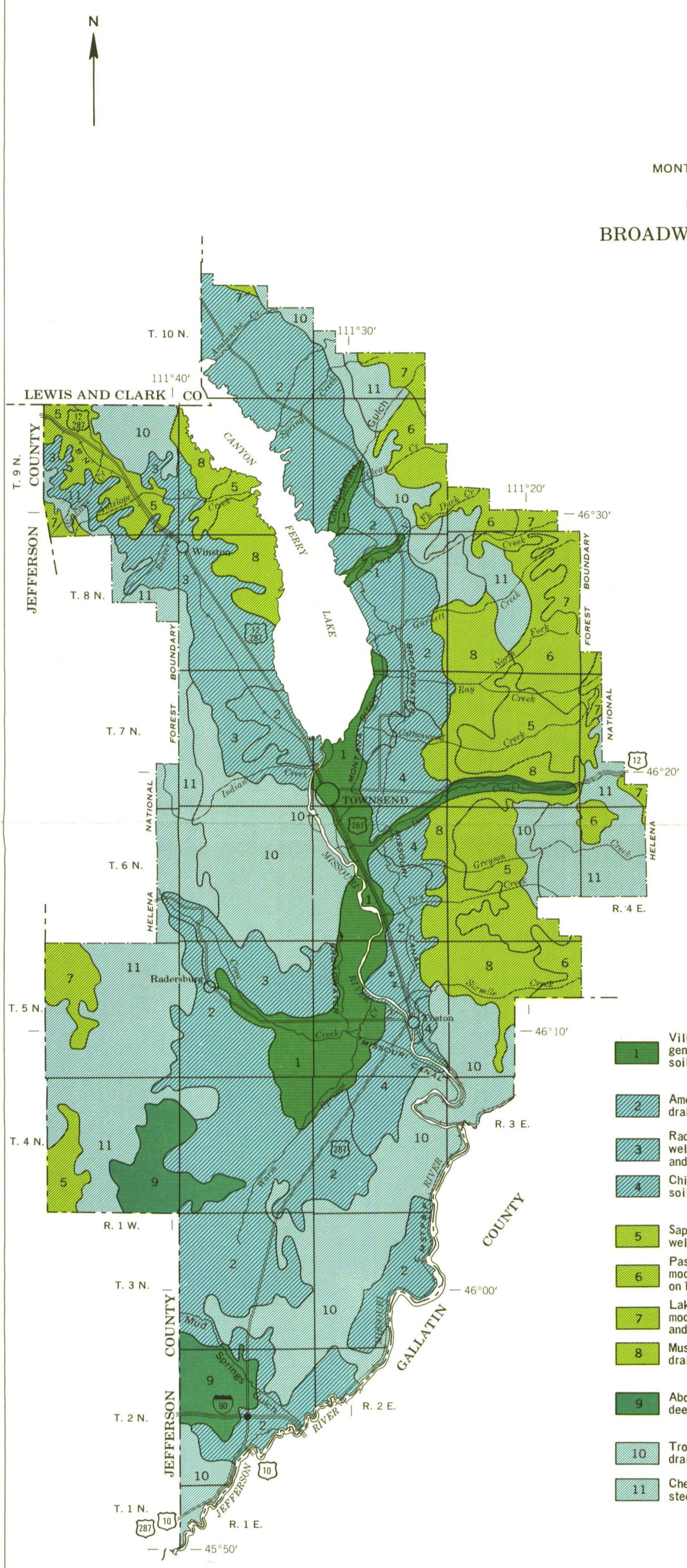
MONTANA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

BROADWATER COUNTY AREA, MONTANA

Scale 1:316,800

1 0 1 2 3 4 5 Miles



SOIL ASSOCIATIONS

SOILS ON BOTTOM LAND

1 — Villy-Toston-Rivra association: Nearly level to gently sloping and gently undulating, deep, poorly drained to moderately well drained soils on low terraces and flood plains

SOILS MAINLY ON INTERMEDIATE TERRACES AND FANS

2 — Amesha-Brocko-Mussel association: Nearly level to steep, deep, well-drained soils on terraces and fans

3 — Radersburg-Hilger-Scravo association: Nearly level to steep, deep, well-drained and somewhat excessively drained soils on terraces, fans, and mountain foot slopes

4 — Chinook-Amesha association: Nearly level to steep, deep, well-drained soils on terraces, fans, and uplands

SOILS MAINLY ON HIGH TERRACES AND FANS

5 — Sappington-Martinsdale association: Gently sloping and sloping, deep, well-drained soils on terraces, fans, and benches

6 — Passcreek-Bridger-Rooset association: Sloping and rolling to steep, moderately deep and deep, well-drained soils on terraces and fans, and on benches, ridges, and side slopes of uplands

7 — Lake Creek-Whitore-Loberg association: Moderately steep to very steep, moderately deep and deep, well-drained soils on mountainous uplands and high fans

8 — Musselshell-Crago association: Gently sloping to steep, deep, well-drained soils on terraces, fans, and foot slopes

SOILS ON SHALE AND SANDSTONE UPLANDS

9 — Abor-Cabbart-Delphill association: Gently sloping to steep, moderately deep and shallow, well-drained soils on uplands

SOILS ON MOUNTAINOUS UPLANDS

10 — Tropal-Rencot-Tolman association: Hilly to very steep, shallow, well-drained soils of the mountains

11 — Cheadle-Nielsen-Ess association: Moderately steep and hilly to very steep, shallow and deep, well-drained soils of the mountains

Compiled 1976

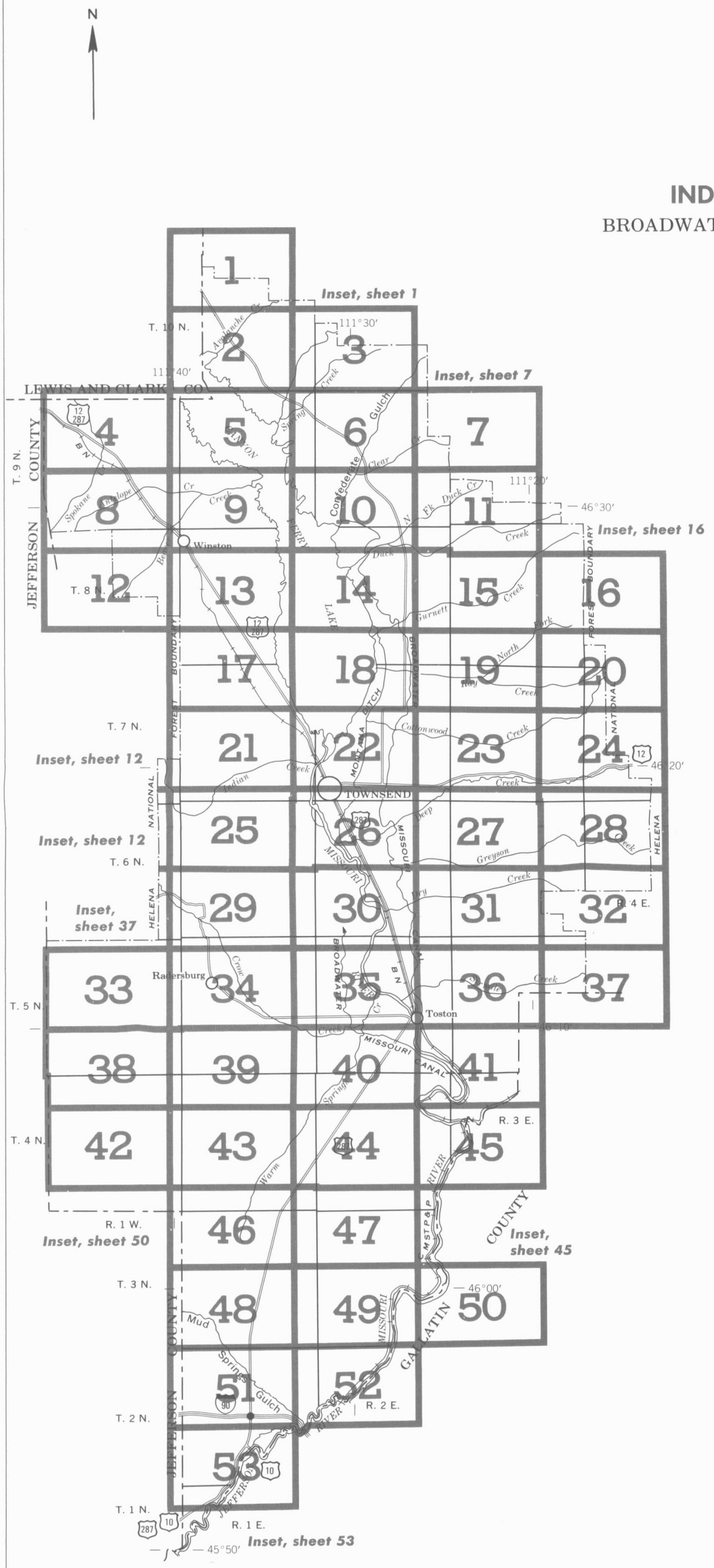
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS

BROADWATER COUNTY AREA, MONTANA

Scale 1:316,800

1 0 1 2 3 4 5 Miles



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Most symbols without a slope letter are those of nearly level soils.

SYMBOL	NAME
AbC	Abor silty clay, 3 to 9 percent slopes
Af	Aeric Fluvaquents
AmB	Amesha sandy loam, 1 to 4 percent slopes
AmC	Amesha sandy loam, 4 to 9 percent slopes
AnB	Amesha cobbly sandy loam, 1 to 4 percent slopes
AoB	Amesha loam, 1 to 4 percent slopes
AoC	Amesha loam, 4 to 9 percent slopes
BcE	Blaine-Cheadle complex, 10 to 25 percent slopes
BdC	Blanyon clay loam, 3 to 10 percent slopes
Bo	Borohemists
BpD	Bridger cobbly loam, 5 to 15 percent slopes
BrD	Bridger silt loam, 5 to 15 percent slopes
BsA	Brocko silt loam, 0 to 2 percent slopes
BsB	Brocko silt loam, 2 to 5 percent slopes
BsC	Brocko silt loam, 5 to 9 percent slopes
BsD	Brocko silt loam, 9 to 25 percent slopes
BtA	Brocko silt loam, wet, 0 to 2 percent slopes
CaE	Cabbart complex, 9 to 35 percent slopes
CdE	Cheadle stony loam, 9 to 35 percent slopes
ChB	Chinook sandy loam, 1 to 4 percent slopes
ChC	Chinook sandy loam, 4 to 9 percent slopes
CkB	Chinook sandy loam, gravelly subsoil variant, 1 to 4 percent slopes
CmC	Chinook-Crago loamy sands, 1 to 9 percent slopes
CnC	Chinook-Crago complex, 5 to 9 percent slopes
CnE	Chinook-Crago complex, 9 to 35 percent slopes
CrC	Crago complex, 4 to 9 percent slopes
DeB	Delphill loam, 2 to 5 percent slopes
DhD	Delphill-Abor complex, 5 to 20 percent slopes
Do	Dominic soils
EcF	Ess-Cheadle complex, 35 to 60 percent slopes
Fa	Fairdale silt loam
Fb	Fairdale-Lothair silty clays
Fd	Fluvaquentic Haplaquolls
Ha	Havre loam
HgE	Hilger extremely stony loam, 8 to 25 percent slopes
LaF	Lake Creek channery loam, 20 to 50 percent slopes
LoE	Loberg very stony loam, 10 to 35 percent slopes
Lt	Lothair silty clay
MaB	Martinsdale loam, 2 to 5 percent slopes
MaC	Martinsdale loam, 5 to 9 percent slopes
McC	Martinsdale cobbly loam, 2 to 9 percent slopes
Md	Mine dumps
MsA	Mussel loam, 0 to 2 percent slopes
MsB	Mussel loam, 2 to 5 percent slopes
Mt	Mussel-Crago complex
MuB	Mussel-Musselshell complex, 2 to 5 percent slopes
MuC	Mussel-Musselshell complex, 5 to 9 percent slopes
MvB	Musselshell gravelly loam, 2 to 5 percent slopes
MvC	Musselshell gravelly loam, 5 to 9 percent slopes
MwE	Musselshell-Crago channery loams, 15 to 35 percent slopes
MxE	Musselshell-Crago cobbly loams, 8 to 20 percent slopes
MyC	Musselshell-Thess cobbly loams, 3 to 8 percent slopes
NeF	Nielsen channery loam, 15 to 60 percent slopes
PaD	Passcreek channery silt loam, 6 to 15 percent slopes
PcE	Passcreek-Lake Creek channery loams, 15 to 35 percent slopes
Pm	Perma very cobbly loam
Pr	Perma very cobbly loam, wet
Ra	Radersburg very cobbly loam
ReE	Rencot channery loam, 15 to 35 percent slopes
Rr	Rivra gravelly loam
RsE	Rooset extremely stony loam, 9 to 35 percent slopes
RtC	Rootel channery loam, 3 to 9 percent slopes
SaB	Sappington clay loam, 2 to 5 percent slopes
SaC	Sappington clay loam, 5 to 9 percent slopes
SgB	Sappington gravelly clay loam, 2 to 5 percent slopes
SgC	Sappington gravelly clay loam, 5 to 9 percent slopes
Sv	Scravo cobbly loam
Sw	Scravo very cobbly loam
Te	Thess silt loam
Ts	Thess-Scravo complex
TtE	Tolman channery loam, 10 to 35 percent slopes
Tu	Toston silty clay loam
TvF	Tropal-Rock outcrop complex, 15 to 60 percent slopes
Uf	Ustic Torrifluvents
Ut	Ustic Torriorthents, saline
Va	Villy silty clay loam
Vd	Villy silty clay loam, drained
WhF	Whitore channery silt loam, 25 to 60 percent slopes
WnE	Windham cobbly loam, 9 to 35 percent slopes
WoF	Woodrock-Loberg complex, 15 to 60 percent slopes
WrE	Woodrock-Rock outcrop complex, 15 to 35 percent slopes

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 1

1 460 000 FEET

R. 1 E.

980 000 FEET

1 485 000 FEET

HELENA NATIONAL FOREST BOUNDARY

LIMIT OF SOIL SURVEY

96 7000 FEET

13

TvF

MxE

(Joins lower right)

T. 10 N.

965 000 FEET

R. 1 E.

(Joins sheet 3)

1 490 000 FEET

2000 AND 5000-FOOT GRID TICKS

LEWIS AND CLARK COUNTY

5

MwE

MyC

MxE

TvF

8

AoB

MwE

9

MvB

AoC

Gulch

10

Uf

Hellgate

Ts

Creek

Avalanche

Te

17

16

15

14

(Joins sheet 2)

1 480 000 FEET

1965 000 FEET

(Joins upper left)

T. 10 N.

N

2 Miles

10000 Feet

Scale 1:24000

5000 4000 3000 2000 1000 0 0 1000 2000 3000 4000 5000

2

N

(Joins sheet 1)

R. 1 E.

1 480 000 FEET

960 000 FEET

T. 10 N.

(Joins sheet 3)

950 000 FEET

1 455 000 FEET

(Joins sheet 5)

2 Miles

10000 Feet

Scale 1:24000

5000

0

1000

2000

3000

4000

5000

LEWIS AND CLARK COUNTY

CANYON FERRY LAKE

SOIL SURVEY OF LIMIT

Hellgate Gulch

Avalanche Gulch

Bilk Creek

water

17 16 15 14

20 21 22 23

29 28 27 26

32 33 34 35

AoB AoC MwE Uf Sv Te Ts MxE MvC

BROADWATER COUNTY AREA, MONTANA NO. 2

This map is compiled on 1955 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 3

1 485 000 FEET *(Joins inset, sheet 1)*

R. 1 E. | R. 2 E.

960 000 FEET

T. 10 N.

(Joins sheet 2)

(Joins inset, sheet 7)

(Joins sheet 6

1 510 000 FEET

945 000 FEET

HELENA NATIONAL FOREST BOUNDARY
LIMIT OF SOIL SURVEY

Creek

Spring

Gulch

N

2 Miles

10000 Feet

Scale 1:24000

1	0	1 000	2000	3000	4000	5000
	0	¼	½	¾	1	

BROADWATER COUNTY AREA, MONTANA NO. 4

This map is compiled on 1955 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 5

R. 1 W. | R. 1 E.

1 455 000 FEET

945 000 FEET

LEWIS AND CLARK COUNTY

T. 9 N.

CANYON FERRY LAKE

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 6)

(Joins sheet 9)

930 000 FEET

1 480 000 FEET

5

N

2 Miles

10000 Feet

Scale 1:24000

BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 6

6

N

R. 1 E. | R. 2 E.

(Joins sheet 3)

1 510 000 FEET

940 000 FEET

930 000 FEET

1 485 000 FEET

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 10)

T. 9 N.

2 Miles

10000 Feet

Scale 1:24000

5000

0

1000

2000

3000

4000

5000

BROADWATER COUNTY AREA, MONTANA NO. 6

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 7

7

N

R. 2 E.

1 515 000 FEET

940 000 FEET

T. 9 N.

(Joins inset)

(Joins sheet 6)

HELENA NATIONAL FOREST BOUNDARY

LIMIT OF SOIL SURVEY

NeF

LaF

BpD

RsE

PaD

HgE

Woods Creek

Hinaman Creek

Clear Creek

2

11

14

13

23

24

(Joins sheet 11)

1 514 000 FEET R. 2 E.

955 000 FEET

T. 10 N.

(Joins sheet 3)

26

35

Gulch

Confederate

McC

MaC

945 000 FEET

(Joins upper left)

1 517 000 FEET

930 000 FEET

1 540 000 FEET

2 Miles

10 000 Feet

5 000

0

1 000

2 000

3 000

4 000

5 000

Scale 1:24000

N

(Joins sheet 4)

R. 1 W.

1 450 000 FEET

925 000 FEET

910 000 FEET

1 425 000 FEET

T. 8 N. | T. 9 N.

(Joins sheet 9)

(Joins sheet 12)

2 Miles

10000 Feet

Scale 1:24000

1 5000 0 1 000 2 000 3 000 4 000 5 000

HELENA NATIONAL FOREST BOUNDARY

HELENA NATIONAL FOREST LIMIT OF SOIL SURVEY BOUNDARY

BURLINGTON NORTHERN

Sheep Creek

Antelope Creek

Spokane Creek

Stalbach Creek

Bridger Creek

19 20 21 22 23 24

30 29 28 27 26 25

31 32 33 34 35 36

3 2 1

HgE EcF MaC Pr Pm McC WnE MaB Fd MvC WoF BpD WrE RsE Af Da

12 287

BROADWATER COUNTY AREA, MONTANA NO. 8

This map is compiled on 1955 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 9

R. 1 W. | R. 1 E.

1 455 000 FEET

925 000 FEET

T. 9 N.

T. 8 N.

(Joins sheet 8)

(Joins sheet 5)

(Joins sheet 18)

(Joins sheet 13)

1 480 000 FEET

1 910 000 FEET

CANYON FERRY LAKE

Beaver Creek

Antelope Creek

Stalbrick Creek

Winston

BURLINGTON NORTHERN

12 287

9

N

2 Miles

10000 Feet

5000

Scale 1:24000

10

N

2 Miles

10000 Feet

1 5000

Scale 1:24000

0 0

¼ 1000

½ 2000

¾ 3000

1 4000

5000

R. 1 E. | R. 2 E.

(Joins sheet 6)

1 510 000 FEET

925 000 FEET

(Joins sheet 9)

910 000 FEET

1 485 000 FEET

(Joins sheet 14)

T. 8 N. | T. 9 N. (Joins sheet 11)

CANYON FERRY LAKE

Clear Creek

Gulch

Confederate Gulch

Duck Creek

North Fork Duck Creek

19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 1 2 3 4 5 6

AmC AmB AnB AoB AoC Af BsB BtA CnC CrC Fa Fd HgE MvB MwE MxE MyC RtC ReE SaB SaC SgC Ts Te TtE Uf Va

BROADWATER COUNTY AREA, MONTANA NO. 1C

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid (ticks and land division corners, if shown) are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Controlled grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 11

(Joins sheet 7)

1 515 000 FEET

R. 2 E. | R. 3 E.

925 000 FEET

HELENA NATIONAL FOREST BOUNDARY LIMIT OF SURVEY

Duck Creek

Middle Fork

Duck Creek

HELENA NATIONAL FOREST BOUNDARY

T. 8 N. | T. 9 N.

910 000 FEET

(Joins sheet 10)

(Joins inset, sheet 16)

(Joins sheet 15)

1 540 000 FEET

11

N

2 Miles

10000 Feet

5000

Scale 1:24000

N

2 Miles

10000 Feet

1 5000

Scale 1:24000

1 ¼ ½ ¾ 1 5000 4000 3000 2000 1000 0 0

INSET B

R. 1 W.

(Joins inset A)

1 450 000 FEET

850 000 FEET

T. 6 N. | T. 7 N.

(Joins sheet 25)

895 000 FEET

835 000 FEET

1 425 000 FEET

1 448 000 FEET

(Joins inset, sheet 37)

2000 AND 5000-FOOT GRID TICKS

INSET A

R. 1 W.

1 45 1000 FEET

860 000 FEET

855 000 FEET

T. 7 N.

(Joins sheet 21)

1 449 000 FEET

(Joins inset B)

2000 AND 5000-FOOT GRID TICKS

(Joins sheet 8)

R. 1 W.

1 450 000 FEET

905 000 FEET

T. 8 N.

(Joins sheet 13)

HELENA NATIONAL FOREST BOUNDARY

North Pole Creek

South Pole Creek

Beaver Creek

Indian Creek

EcF MaC Af HgE Pm Do Ra CdE BcE BpD

10 11 12 13 14 15 24 25 36 1

BROADWATER COUNTY AREA, MONTANA NO. 12

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 13

R. 1 W. | R. 1 E.
1 455 000 FEET

905 000 FEET

T. 8 N.

(Joins sheet 9)

(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 17)

1 480 000 FEET

890 000 FEET

NORTHERN

BURLINGTON

LIMIT OF HELENA NATIONAL FOREST SOIL SURVEY BOUNDARY

CANYON FERRY LAKE

12 287

Pm Pr Ra McC MaC HgE MwE SgB SgC MvC MxE MyC MvB EcF Fd

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 27 28 29 30

N

2 Miles 1 0

10000 Feet 5000 0

Scale 1:24000

1 ¼ ½ ¾ 1

5000 4000 3000 2000 1000 0

14

N

2 Miles

10000 Feet

1

5000

Scale 1:24000

0 0

¼ 1000

½ 2000

¾ 3000

4000

1 5000

(Joins sheet 10) R. 1 E. | R. 2 E.

1 510 000 FEET

905 000 FEET

T. 8 N.

(Joins sheet 13)

CANYON FERRY LAKE

(Joins sheet 15)

830 000 FEET

(Joins sheet 18) 1 485 000 FEET

BROADWATER COUNTY AREA, MONTANA NO. 14

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1963 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 15

1 515 000 FEET

R. 2 E. | R. 3 E.

905 000 FEET

T. 8 N.

(Joins sheet 11)

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 19)

890 000 FEET

1 535 000 FEET

Duck Creek

Current Creek

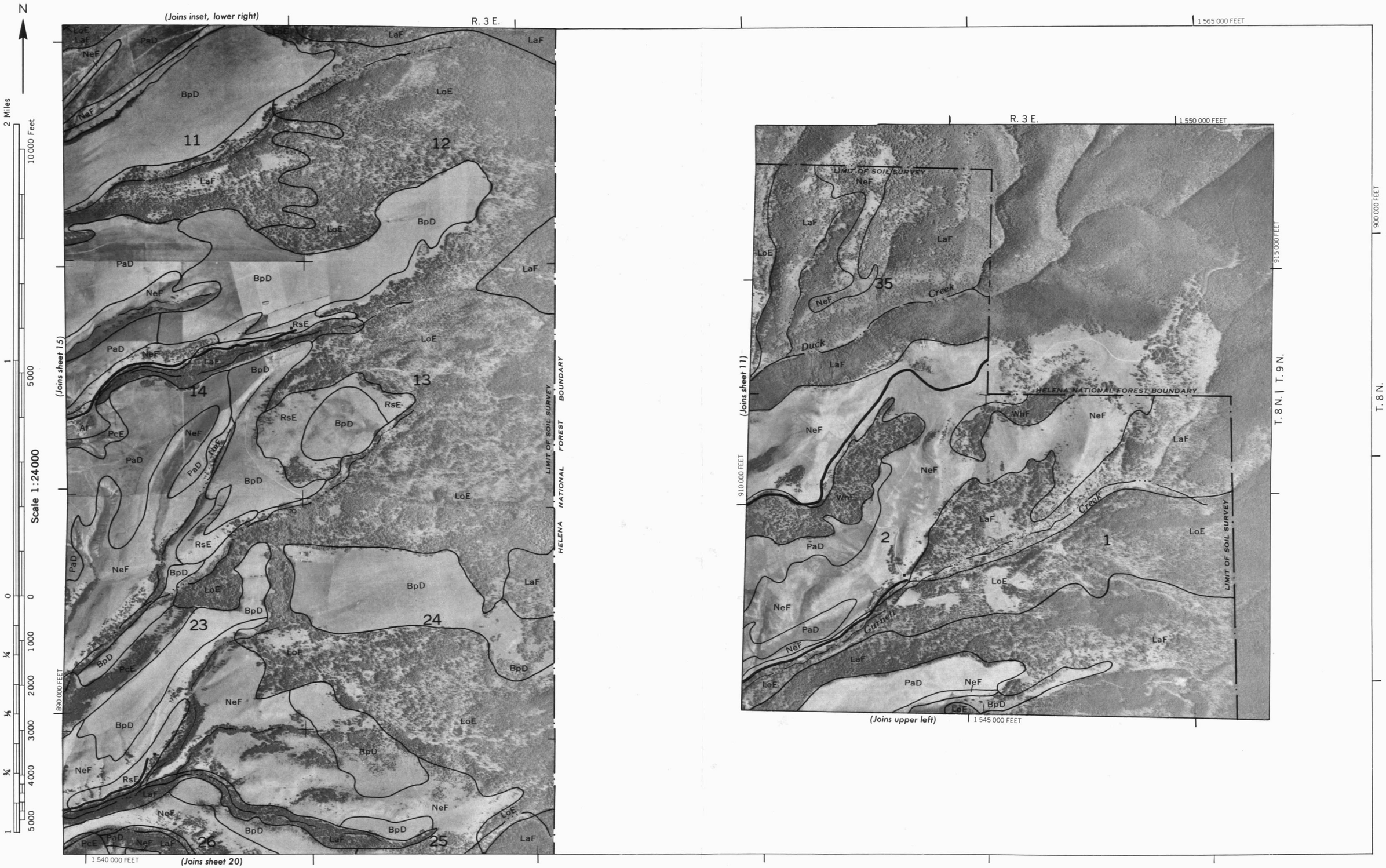
N

2 Miles

10000 Feet

5000

Scale 1:24000



BROADWATER COUNTY AREA, MONTANA NO. 16

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land diversion corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 17

R. 1 W. | R. 1 E.

1 455 000 FEET

890 000 FEET

T. 7 N. | T. 8 N.

(Joins sheet 13)

CANYON

FERRY

LAKE

BURLINGTON

NORTHERN

SOIL FOREST SURVEY BOUNDARY

HELENA NATIONAL FOREST BOUNDARY

(Joins sheet 18)

875 000 FEET

(Joins sheet 21)

1 480 000 FEET

N

2 Miles

10000 Feet

Scale 1:24000

30 29 28 27 26

31 32 33 34 35

6 5 4 3 2

7 8 9 10 11

EcF Ra Fd MvB MyC MvC Af WoF Pr TtE MxE Te MyC

N

2 Miles

10000 Feet

1

5000

Scale 1:24000

0

0

1000

2000

3000

4000

5000

(Joins sheet 14)

R. 1 E. | R. 2 E.

(Joins sheet 17)

CANYON FERRY LAKE

875 000 FEET

(Joins sheet 22)

1 485 000 FEET

1 510 000 FEET

885 000 FEET

T. 7 N. | T. 8 N.

(Joins sheet 19)

28 27 26

33 34 35

4 3 2

9 10 11

Te MwE Sv Ts Va AoB BtA Tu Uf Mt Ha BsA Ts AoC MsA MsB AnB MyC CnE CkB Fa Vd

G.P.

CANAL

DITCH

MISSOURI

MONTANA

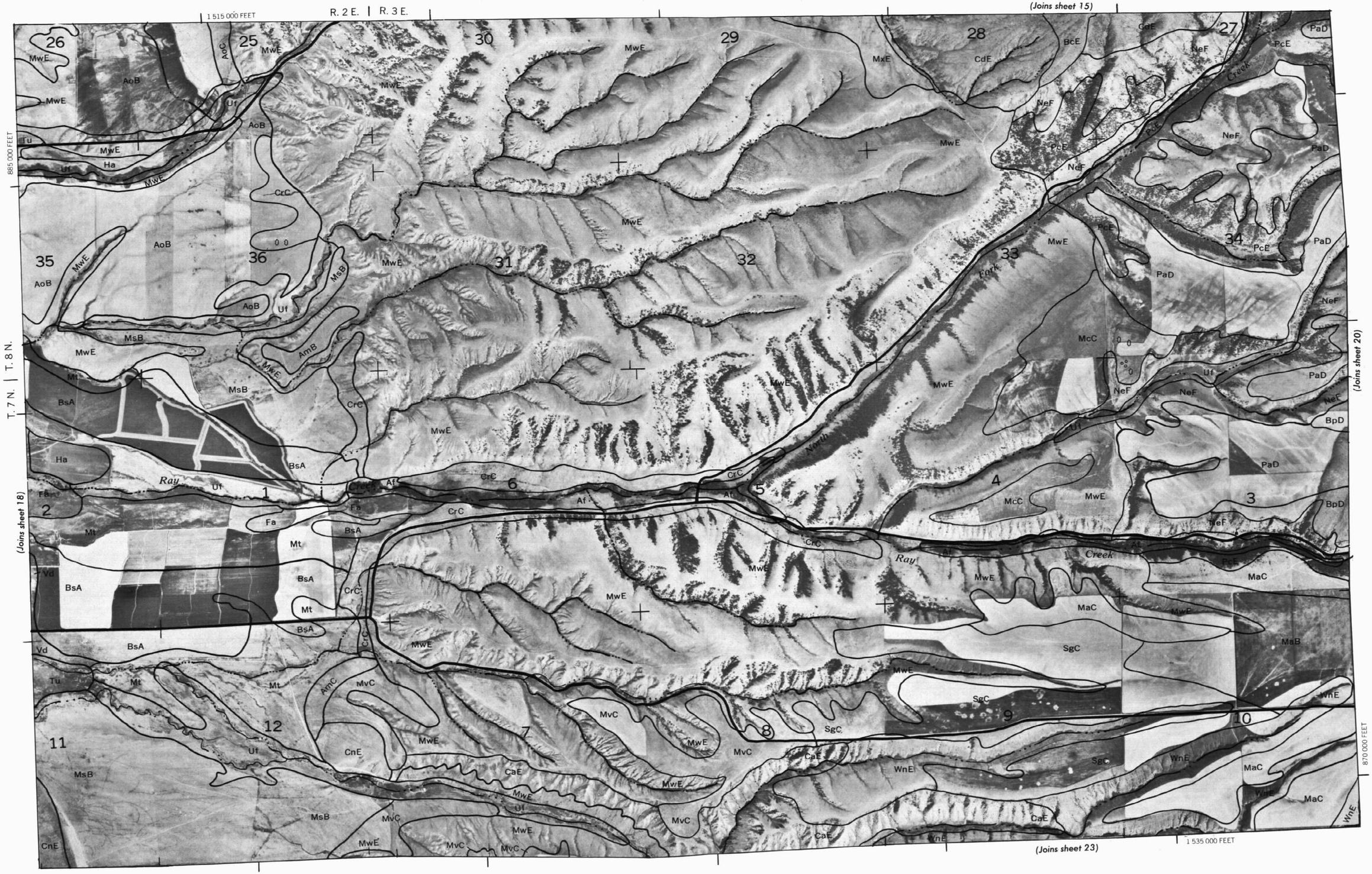
BROADWATER

IRISH DITCH

MANLEY

BROADWATER COUNTY AREA, MONTANA NO. 18

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

2 Miles

10000 Feet

Scale 1:24000

1 0 5000

¼ 0 1000

½ 2000

¾ 3000

1 4000 5000

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 19

20

N

2 Miles

10000 Feet

Scale 1:24000

1 5000 0 1000 2000 3000 4000 5000

(Joins sheet 16)

(Joins sheet 19)

(Joins sheet 24)

R. 3 E. | R. 4 E.

1 565 000 FEET

885 000 FEET

870 000 FEET

1 540 000 FEET

T. 7 N. | T. 8 N.

LIMIT OF SOIL SURVEY

BOUNDARY

FOREST

NATIONAL

HELENA

Creek

Ray

26 25 35 36 31 2 1 6 11 12 7

PcE PaD NeF LaF RsE BpD LoE MaC MaB WnE McC

BROADWATER COUNTY AREA, MONTANA NO. 20

This map is compiled on 1955 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 21

21

R. 1 W. | R. 1 E.

1 455 000 FEET

870 000 FEET

T. 7 N.

(Joins sheet 17)

(Joins inset, sheet 12)

(Joins sheet 22)

(Joins sheet 25)

1 480 000 FEET

855 000 FEET

N

2 Miles

10000 Feet

Scale 1:24000

HELENA NATIONAL FOREST SOIL SURVEY BOUNDARY

BURLINGTON NORTHERN

Indian Creek

12 287

18 17 16 15 14

19 20 21 22 23

25 30 29 28 27 26

36 31 32 33 34 35

TtE MxE MyC Ra Te EcF RsE ReE TvF Pm Md MvB MwE

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA NO. 21

22

N

(Joins sheet 18) | R. 1 E. | R. 2 E. | 1 510 000 FEET | 870 000 FEET

CANYON FERRY LAKE

Cottonwood Creek

Indian Creek

MISSOURI RIVER

NORTHERN PACIFIC RAILROAD

BURLINGTON

MILWAUKEE

MONTANA

MISSOURI CANAL

BROADWATER

DITCH

MANLEY DITCH

US 12 287

Townsend Landing Field

TOWNSEND (County seat)

13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

T. 7 N.

(Joins sheet 21) | 855 000 FEET | (Joins sheet 23) | (Joins sheet 26) | 1 485 000 FEET

Scale 1:24000

2 Miles | 10000 Feet | 5000 | 0 | 1000 | 2000 | 3000 | 4000 | 5000

BROADWATER COUNTY AREA, MONTANA NO. 22

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately correct

BROADWATER COUNTY AREA, MONTANA NO. 23

1 515 000 FEET

R. 2 E. | R. 3 E.

(Joins sheet 19)

870 000 FEET

T. 7 N.

(Joins sheet 22)

(Joins sheet 24)

855 000 FEET

(Joins sheet 27)

1 535 000 FEET

N

Scale 1:24000

7 Miles

10000 Feet

5000

1

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

24

N

R. 3 E. | R. 4 E.

(Joins sheet 20)

1 565 000 FEET

865 000 FEET

T. 7 N.

855 000 FEET

1 540 000 FEET

(Joins sheet 28)

(Joins sheet 23)

2 Miles

10000 Feet

Scale 1:24000

1 0 5000

¼ 0 1000

¼ 2000

¼ 3000

¼ 4000

1 5000

Cottonwood Creek

Deep Creek

North Fork Deep Creek

HELENA NATIONAL FOREST BOUNDARY

LIMIT OF SOIL SURVEY

12

13 14 18 19 23 24 25 26 29 30 31 32 33 35 36

WnE MaC MaB Uf CaE PaD PcE NeF McC Af MxE TvF LaF BdC MwE SaC SaB CrC BsD Fa

BROADWATER COUNTY AREA, MONTANA NO. 24

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 25

R. 1 W. | R. 1 E. | 1 455 000 FEET

T. 6 N. | T. 7 N. | 850 000 FEET

(Joins sheet 21)

(Joins inset B, sheet 12)

(Joins sheet 26)

1 475 000 FEET (Joins sheet 29)

835 000 FEET

25

N

2 Miles

10000 Feet

Scale 1:24000

1 0 1 ½ 0 1 000 2 000 3 000 4 000 5 000

¾ ¾ 5 000

26

N

2 Miles 1 0 10000 Feet

1 5000 0

Scale 1:24000

¼ 0 1000

½ 2000 3000

¾ 4000 5000

1 5000

R. 1 E. | R. 2 E.

1 505 000 FEET

850 000 FEET

T. 6 N. | T. 7 N.

835 000 FEET

1 480 000 FEET

(Joins sheet 22)

(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 30)

TOWNSEND

287

MISSOURI RIVER

MONTANA

NORTHERN

BURLINGTON

DITCH

CANAL

Deep Creek

Reservoir

BROADWATER

Grayson Creek

Sections: 36, 31, 32, 33, 34, 35; 1, 6, 5, 4, 3, 2; 12, 7, 8, 9, 10, 11; 13, 18, 17, 16, 15, 14

MxE TtE Rr Tu Ut Af Va ChB CkB CmC CnE CnC MwE BtA BsA Vd Ts AnB Mt CrC BsB Fa SaC AmB AmC Uf MsA MsB Te Fd

BROADWATER COUNTY AREA, MONTANA NO. 26

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinating grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 27

27

N

1 510 000 FEET

R. 2 E. | R. 3 E.

(Joins sheet 23)

850 000 FEET

T. 6 N. | T. 7 N.

(Joins sheet 26)

(Joins sheet 28)

(Joins sheet 31)

1 535 000 FEET

835 000 FEET

Creek

Deep Creek

Greyson Creek

2 Miles

10000 Feet

Scale 1:24000

5000

1 0 1 0

¼ ½ ¾ 1 1¼ 1½ 1¾ 2 2¼ 2½ 2¾ 3 3¼ 3½ 3¾ 4 4¼ 4½ 4¾ 5 5000

N

2 Miles

10000 Feet

1

5000

Scale 1:24000

0 1000 2000 3000 4000 5000

¼ ½ ¾

(Joins sheet 24)

R. 3 E. | R. 4 E.

1 565 000 FEET

845 000 FEET

T. 6 N. | T. 7 N.

835 000 FEET

1 540 000 FEET

(Joins sheet 27)

(Joins sheet 32)

35 36 31 32 33

2 1 6 5 4

11 12 7 8 9

14 13 18 17 16

MxE ReE SaB SaC SaB BsD Uf NeF PaD BpD LaF Af

Greyson Creek

NATIONAL FOREST BOUNDARY

HELENA

BROADWATER COUNTY AREA, MONTANA NO. 28

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 29

29

R. 1 W. | R. 1 E.

1 455 000 FEET

(Joins sheet 25)

830 000 FEET

(Joins inset A, sheet 37)

T. 5 N. | T. 6 N.

(Joins sheet 30)

815 000 FEET

(Joins sheet 34)

1 475 000 FEET

N

2 Miles

10000 Feet

Scale 1:24000

5000 4000 3000 2000 1000 0 0 5000

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 29

30

N

R. 1 E. | R. 2 E.

(Joins sheet 26)

(Joins sheet 29)

(Joins sheet 31)

(Joins sheet 35)

1 505 000 FEET

1 480 000 FEET

815 000 FEET

830 000 FEET

T. 5 N. | T. 6 N.

2 Miles

10000 Feet

Scale 1:24000

1 5000 0 1000 2000 3000 4000 5000

MISSOURI RIVER

BROADWATER MISSOURI CANAL

BURLINGTON NORTHERN

FAIRCHILD BROADWATER CANAL

MISSOURI CANAL

Dry Creek

287

TtE MyC Af Rr Uf Fd BsA Ha Fb MxE AoC ReE CrC Tu G.P. MsA Mt CkB CnE AmB AoC MwE Holker Fa Ut MsB Sv MvC MvB Te Lt BsB Mt

19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 1 2 3 4 5 6

BROADWATER COUNTY AREA, MONTANA NO. 30

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 31

31

N

1 510 000 FEET

R. 2 E. | R. 3 E.

(Joins sheet 27)

830 000 FEET

T. 5 N. | T. 6 N.

(Joins sheet 30)

(Joins sheet 32)

815 000 FEET

(Joins sheet 36) | 1 535 000 FEET

Scale 1:24000

2 Miles 1 0 10000 Feet 5000 0

1 ¼ ½ ¾ 0 1000 2000 3000 4000 5000

32

N

R. 3 E. | R. 4 E.

(Joins sheet 28)

1 565 000 FEET

830 000 FEET

(Joins sheet 31)

23 24 19 20 21

NeF LaF BpD TvF WhF

Dry Creek

HELENA NATIONAL FOREST BOUNDARY

HELENA NATIONAL FOREST

HELENA NATIONAL FOREST BOUNDARY

35 36 1 2

MxE MwE SaC Af WnE BrD CaE Hollow

815 000 FEET

1 540 000 FEET

(Joins sheet 37)

T. 5 N. | T. 6 N.

2 Miles 10000 Feet

Scale 1:24000

1 5000 0 1000 2000 3000 4000 5000

BROADWATER COUNTY AREA, MONTANA NO. 32

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 33

33

N

1 425 000 FEET

R. 1 W.

(Joins inset A, sheet 37)

815 000 FEET

T. 5 N.

JEFFERSON COUNTY

North Fork

Johnny Gulch

Keating Gulch

Gulch

(Joins sheet 34)

(Joins sheet 38)

800 000 FEET

1 450 000 FEET

2 Miles

10000 Feet

Scale 1:24000

2 Miles
10000 Feet
Scale 1:24000
5000

BROADWATER COUNTY AREA, MONTANA NO. 34

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 35

35

N

R. 1 E. | R. 2 E.

1 480 000 FEET

815 000 FEET

T. 5 N.

(Joins sheet 30)

(Joins sheet 34)

(Joins sheet 36)

(Joins sheet 40)

1 505 000 FEET

800 000 FEET

BARRINGER DITCH

BROADWATER

MISSOURI

MISSOURI RIVER

CANAL

BROADWATER MO CANAL

BURLINGTON NORTHERN

Toston

G.P.

W.S. Crow Creek

287

2 Miles

10000 Feet

Scale 1:24000

N

R. 2 E. | R. 3 E.

(Joins sheet 31)

1 535 000 FEET

810 000 FEET

T. 5 N.

(Joins sheet 37)

(Joins sheet 35)

800 000 FEET

1 510 000 FEET

(Joins sheet 41)

Scale 1:24000

2 Miles 10000 Feet

1 5000 0 0 1000 2000 3000 4000 5000

BROADWATER COUNTY AREA, MONTANA NO. 36

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 37

1 540 000 FEET

(Joins sheet 32) R. 3 E.

R. 1 W. (Joins inset B, sheet 12)

810 000 FEET

T. 5 N.

(Joins sheet 36)

805 000 FEET

HELENA NATIONAL FOREST BOUNDARY

GALLATIN COUNTY

1 545 000 FEET

INSET A

1 425 000 FEET

822 000 FEET

JEFFERSON COUNTY T. 5 N. | T. 6 N.

HELENA NATIONAL FOREST BOUNDARY

(Joins sheet 29)

817 000 FEET

(Joins sheet 33)

1 450 000 FEET

N

2 Miles

10000 Feet

Scale 1:24000

38

N

2 Miles

10000 Feet

1

5000

Scale 1:24000

0 0 1000 2000 3000 4000 5000

¼ ½ ¾

(Joins sheet 33)

R. 1 W.

1 450 000 FEET

795 000 FEET

(Joins sheet 39)

T. 4 N. | T. 5 N.

JEFFERSON COUNTY

780 000 FEET

(Joins sheet 42)

1 425 000 FEET

CdE BcE TvF WhF McC TtE HgE Uf MwE MxE MyC CrC DhD AbC AoB BdC RtC SaB

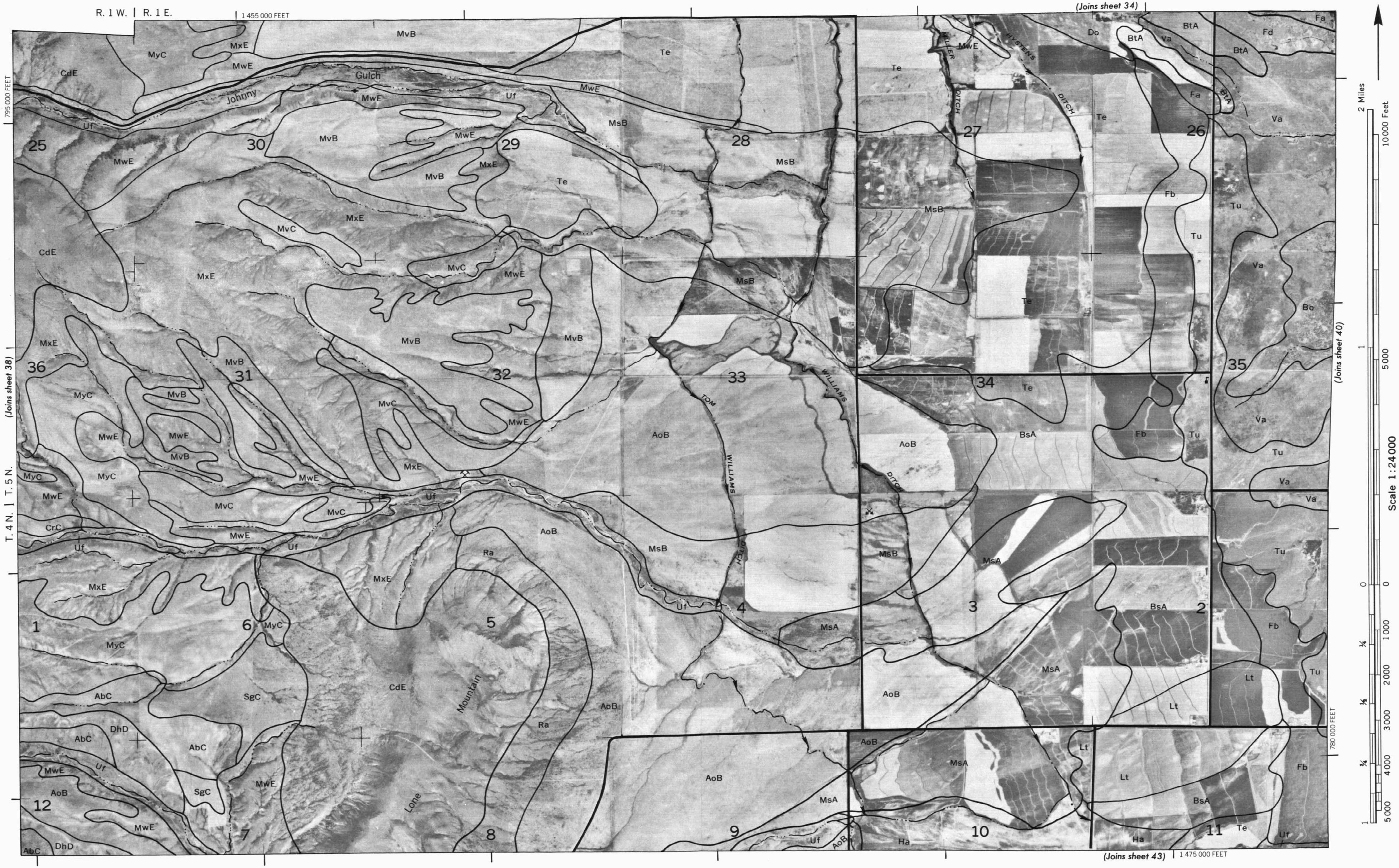
Johnny Gulch

25 26 27 28 29 30 31 32 33 34 35 36

1 2 3 4 5 6 7 8 9 10 11 12

BROADWATER COUNTY AREA, MONTANA NO. 38

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 39

N

2 Miles 10000 Feet

1 5000

Scale 1:24000

0 0 1000 2000 3000 4000 5000

¼ ½ ¾

R. 1 E. | R. 2 E.

(Joins sheet 35)

1 505 000 FEET

795 000 FEET

780 000 FEET

1 480 000 FEET

(Joins sheet 39)

(Joins sheet 41)

(Joins sheet 44)

T. 4 N. | T. 5 N.

Crow Creek

Branch

Spring

Springs

Warm

Creek

BROADWATER

MISSOURI CANAL

MISSOURI RIVER

TOSTON

MWE

287

Pump House

water

25 30 29 28 27 26

36 31 32 33 34 35

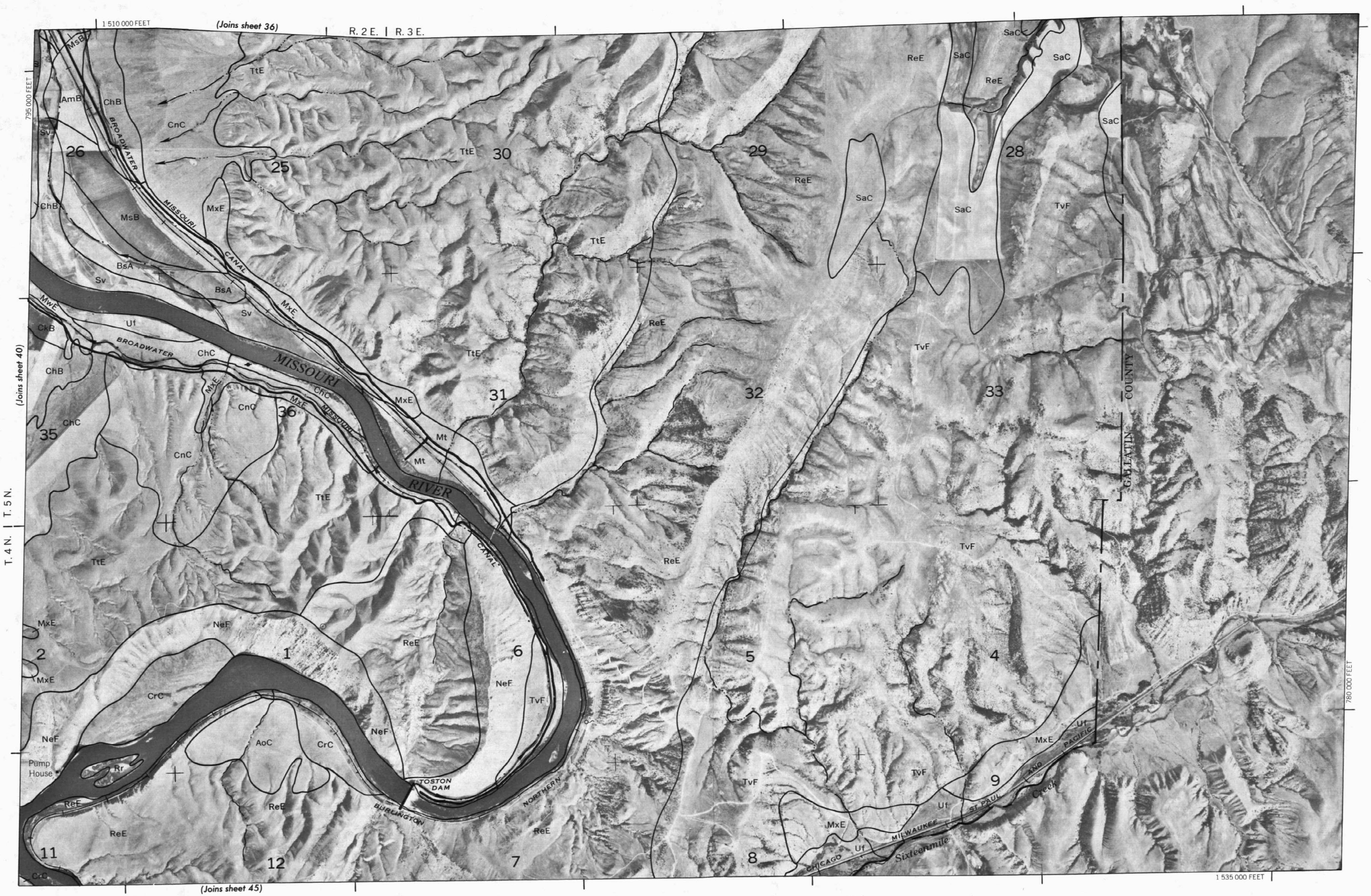
1 6 5 4 3 2

12 7 8 9 10 11

Va Fa Fd Tu Te BtA Bo ChB CkB ChC Sv Ha MxE TtE AmB AmC AoB CnE MsA MsB NeF ReE Uf Fb Ts CrC

BROADWATER COUNTY AREA, MONTANA NO. 40

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 41

N

2 Miles 1 0

10000 Feet 5000 0

Scale 1:24000

1 ¼ ½ ¾ 1

4000 3000 2000 1000 0

(Joins sheet 38)

R. 1 W.

1 445 000 FEET

775 000 FEET

T. 4 N.

JEFFERSON COUNTY

765 000 FEET

(Joins sheet 43)

(Joins inset, sheet 50)

1 425 000 FEET

BROADWATER COUNTY AREA, MONTANA NO. 42

BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 43

43

N

1 450 000 FEET | R. 1 W. | R. 1 E.

(Joins sheet 39)

775 000 FEET

T. 4 N.

(Joins sheet 42)

(Joins sheet 44)

(Joins sheet 46)

1 475 000 FEET

760 000 FEET

Mountain

Lone

Creek

Springs

Plunkel Lake

Warm

2 Miles

10000 Feet

5000

Scale 1:24000

This map is compiled on 1955 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 43

44

N

(Joins sheet 40) R. 1 E. | R. 2 E.

1 505 000 FEET

775 000 FEET

T. 4 N.

(Joins sheet 43)

(Joins sheet 45)

760 000 FEET

1 480 000 FEET (Joins sheet 47)

2 Miles

10000 Feet

Scale 1:24000

1 5000 0 0 1000 ¼ ¼ 2000 ½ ½ 3000 ¾ ¾ 4000 1 5000

BROADWATER COUNTY AREA, MONTANA NO. 44

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 45

45

R. 2 E. | R. 3 E.

1 510 000 FEET

(Joins sheet 41)

775 000 FEET

T. 4 N.

(Joins sheet 44)

MISSOURI RIVER

BURLINGTON NORTHERN Rr

PACIFIC AND ST PAUL Rr

MILWAUKEE Rr

CHICAGO GALLATIN COUNTY Rr

Lombard

Sixteenmile Creek

11 12 7 8 14 13 18 19 23 24 26 25

NeF CrC ReE TtE TvF BsD BsC MwE Af Uf

(Joins upper right)

760 000 FEET

1 525 000 FEET

R. 2 E.

1 510 000 FEET (Joins lower left)

T. 3 N. | T. 4 N.

755 000 FEET

(Joins sheet 47)

35 36 2 1 11 12 14 13

MwE ReE MvC BsC BsD Fa Rr

MISSOURI RIVER

PACIFIC AND ST PAUL MILWAUKEE CHICAGO GALLATIN COUNTY Rr

(Joins sheet 50)

740 000 FEET

1 515 000 FEET

N

2 Miles 10000 Feet 1 5000

Scale 1:24000

1 0 1 000 2 000 3 000 4 000 5 000

46

N

R. 1 W. | R. 1 E. *(Joins sheet 43)*

1 475 000 FEET

(Joins inset, sheet 50)

T. 3 N. | T. 4 N.

755 000 FEET

745 000 FEET

JEFFERSON COUNTY

Tu MwE BsB CaE AoB DhD ReE AbC MyC DeB Uf TvF

36 31 32 33 34 35 6 5 4 3 2 7 8 9 10 11 18 17 16 15 14

Creek Springs Warm

287

2 Miles 10000 Feet

1 5000

Scale 1:24000

0 0 1000 ¼ 2000 ½ 3000 ¾ 4000 1 5000

1 450 000 FEET

(Joins sheet 48)

(Joins sheet 47)

BROADWATER COUNTY AREA, MONTANA NO. 46

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 47

47

N

1 480 000 FEET

R. 1 E. | R. 2 E.

(Joins sheet 44)

T. 3 N. | T. 4 N. 755 000 FEET

(Joins sheet 46)

(Joins inset, sheet 45)

(Joins sheet 49)

1 505 000 FEET

740 000 FEET

2 Miles

10 000 Feet

Scale 1:24000

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 47

N

(Joins sheet 46)

R. 1 E.

1 475 000 FEET

740 000 FEET

T. 3 N.

JEFFERSON COUNTY

725 000 FEET

1 450 000 FEET

(Joins sheet 51)

(Joins sheet 49)

Scale 1:24000

2 Miles 0 1 2 3 4 5

10000 Feet 0 1000 2000 3000 4000 5000

1 0 1/4 1/2 3/4 1

5000 0 1000 2000 3000 4000 5000

Mud Spring Gulch

MWE

287

BROADWATER COUNTY AREA, MONTANA NO. 48

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 49

50

N

Scale 1:24000

2 Miles 1 0 1

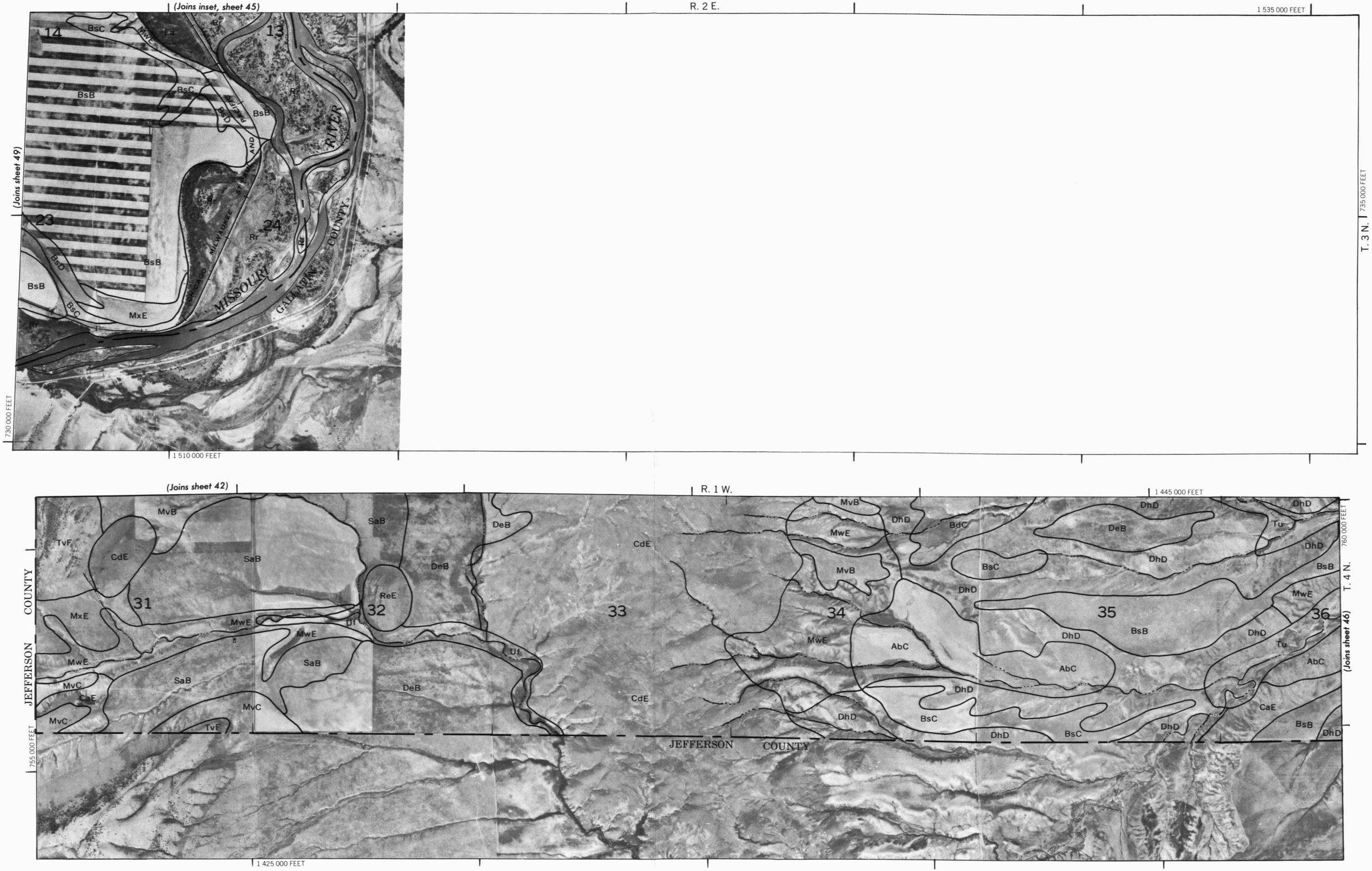
10000 Feet 5000 0 5000

¼ ½ ¾

1000 2000 3000 4000

¾ ½ ¼

5000



BROADWATER COUNTY AREA, MONTANA NO. 50

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 51

1 450 000 FEET

R. 1 E.

(Joins sheet 48)

T. 2 N.

720 000 FEET

JEFFERSON COUNTY

(Joins sheet 52)

(Joins sheet 53)

705 000 FEET

1 475 000 FEET

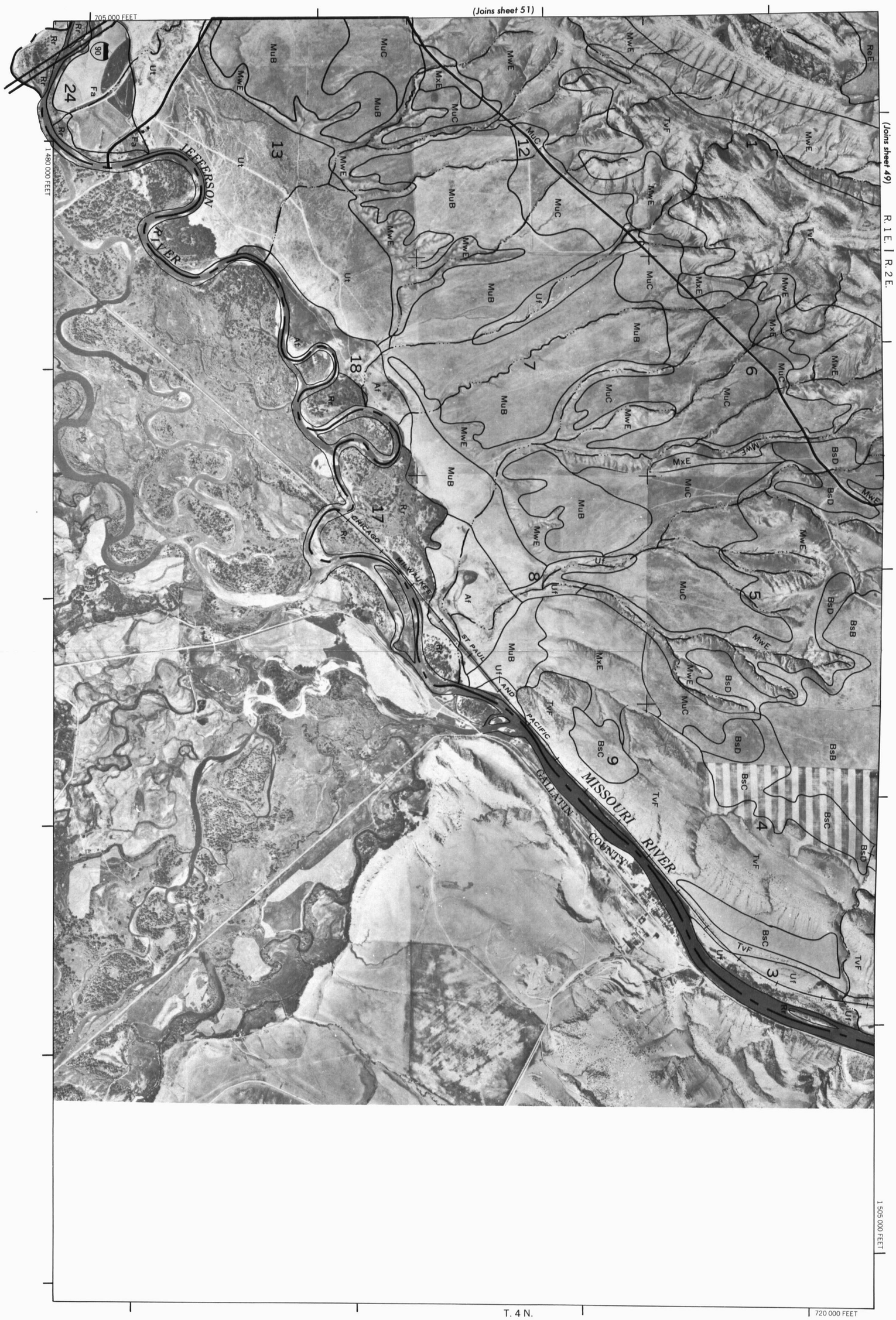
N

Scale 1:24000

2 Miles

10000 Feet

5000



BROADWATER COUNTY AREA, MONTANA — SHEET NUMBER 52

BROADWATER COUNTY AREA, MONTANA NO. 52

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1965 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

BROADWATER COUNTY AREA, MONTANA NO. 53

1 450 000 FEET

705 000 FEET

R. 1 E.

(Joins sheet 51)

N

2 Miles

10000 Feet

5000

4000

Scale 1:24000

T. 1 N. | T. 2 N.

JEFFERSON COUNTY

CALDWELL COUNTY

JEFFERSON RIVER

Milligan Creek

19 20 21 22 23 28 29 30 31 32 33 4 5 6

BsC BsB DeB MwE AoB AoC Uf Rr TvF MxE Tu Fa MsB Af

10 287

(Joins inset, upper right)

(Joins lower left)

685 000 FEET

680 000 FEET

690 000 FEET

1 455 000 FEET

1 475 000 FEET

T. 1 N.

BROADWATER COUNTY AREA, MONTANA

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot